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# AGING COMMERCIAL AIRLINE FLEET

## HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

## COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

NINETY-NINTH CONGRESS

SECOND SESSION

ON

AGING COMMERCIAL AIRLINE FLEET AND ITS SAFETY

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APRIL 15, 1986

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# AGING COMMERCIAL AIRLINE FLEET AND ITS SAFETY

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## TUESDAY, APRIL 15, 1986

U.S. SENATE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
SUBCOMMITTEE ON AVIATION
*Washington, D.C.*

The subcommittee met, pursuant to notice, at 9:36 a.m. in Room SD-628, Senate Dirksen Office Building, Hon. Nancy Kassebaum (Chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Steve Johnson, staff counsel and Steve Palmer, minority professional staff member.

## OPENING STATEMENT BY SENATOR KASSEBAUM

Senator KASSEBAUM. The hearing will please come to order. Unaccustomed as we are to having the Commerce Committee meeting in this room, I very much appreciate the extra effort put forth to hold what I believe is an important hearing. It is really one which in many ways should help educate us.

We have tried, through hearings in the fall and the winter, to explore some of the issues that have been raised concerning aviation safety and our airways system. I feel it is terribly important for us not to point fingers or blame, but to work together to try to address the issues that are before us and the concerns that we all share.

This does not mean that I think in any way believe there is danger in our airways system; however, as changes occur and the different aspects of the regulation of our air transportation system, and the increased travel and the aging of our fleet come together, we must work together to try to assure that we stay ahead of any problems that could arise.

That really is the purpose of this hearing. It is not in any way to castigate the airlines, the manufacturers or the FAA, but rather to focus on perhaps better monitoring techniques and better approaches, to address the concerns that have been raised regarding the aging of our fleet.

The issues that I plan to cover are whether the programs in place are adequate to ensure structural integrity with emphasis on fatigue cracking and corrosion in airframes, adequacy of the maintenance reliability programs for engines, and whether FAA mandatory standards should be raised and how to ensure compliance with the standards that are in place.

I very much appreciate the witnesses who are experts in their field who are here today with us.

Senator Ford, do you have any opening comments?

Senator FORD. Thank you, Madam Chairman. I do not have any opening comments, except I congratulate you on holding this hearing and hopefully as we wander through this minefield, we will be able to glean from it some of the problems of the past and prevent those in the future.

I again compliment you on what you are doing.

Senator KASSEBAUM. Thank you.

Let me say I have had to try and learn a whole new set of acronyms in preparing for this hearing. It is a pleasure to call our first witness, the Honorable James Burnett, Chairman of the National Transportation Safety Board.

Chairman Burnett.

## STATEMENT OF HON. JAMES BURNETT, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD ACCOMPANIED; BY DR. BERNARD LOEB, CHIEF, AVIATION ENGINEERING, BUREAU OF TECHNOLOGY.

Mr. BURNETT. Thank you, Madam Chairman, Senator Ford, members of the subcommittee.

I welcome the opportunity to be here today to share the Safety Board's views on the aging of commercial airplanes. I applaud you for looking into this timely issue and hope the Board's contribution is useful to your efforts.

In the interest of time, I will submit my formal remarks for the record and summarize them briefly. Before beginning, I would like to introduce Dr. Bernard Loeb who is the Chief of our Aviation Engineering Division.

The system of inspection and maintenance for ensuring the safety of the air carrier fleet as it ages has been basically sound thus far. Nonetheless, we do not want historical success in aviation safety to dull our senses to the awesome dangers that come about from lapses in surveillance or acceptance of the status quo.

Operating experience has shown that as airplanes become older, they will require more frequent inspection for structural damage from fatigue and corrosion. This is because fatigue is flight cycle-dependent and corrosion is timie-dependent.

The longer the airplane is in service and the more takeoffs and landings to which it is subjected, the greater is the effect of factors such as fatigu cracking and corrosion on its structural integrity.

However, with adequate inspection and maintenance, extended use of airplanes should not result in degradation of safety. The key question then is: What is adequate? This is not easy to answer, but we should not assume that the frequency and type of inspections adequate in the early stages of an airplane's life will remain so as it ages.

Federal regulations do not address directly the age of airplanes. Neither do they require a manufacturer to determine or estimate fatigue life or safe life for an entire airplane or its frame. Manufacturers generally design planes to have a specific economic life during which airframes should not develop major fatigue cracks.

A question, one of many I will raise here today, is whether or what extent the continuing inspection program is able to assure the detection of problems which might develop as the airplane's operation approaches and passes the economic design criteria.

The Safety Board has investigated many accidents and incidents in which airplanes experience failures in their structure, flight control surfaces, or landing gear because of fatigue cracks or corrosion.

In all, Safety Board data reveal that for the last 15 years, fatigue or corrosion has been mentioned as a probable cause or related factor in 35 of the 554 air carrier accidents during that period. These accidents included older propeller-driven airplanes, turboprop airplanes and the more modern turbojet aircraft.

Fatigue or corrosion was also mentioned 77 times during that period in 579 air carrier incidents. However, few of these accidents or incidents involved fatigue cracking or corrosion of the primary structure of turbojet transport airplanes. In other words, if we look at the turbojet category on which most of us do most of our flying, and you exclude the landing gear fatigue areas, we get down to virtually no incidents or accidents.

Further, there has not been one passenger fatality from a U.S. aviation accident in which the Safety Board has cited fatigue or corrosion in a turbojet transport as a cause or related factor.

None of these occurrences has been attributed to age per se. Most have resulted from inadequate or improper inspection and maintenance. Others were attributed to inadequate design. However, some of these did involve relatively high-time airplanes.

It is possble that had the high-time planes been subjected to more frequent inspections, the fatigue cracks would have been detected. We certainly hope so, but it is an open question.

The FAA program to ensure against this has not been fully implemented nor is its coverage yet as broad as it might be. The FAA's program to determine which components of the older turbojet airplanes require more frequent inspection for fatigue is called the supplemental structural inspection program. It is designed to adjust the frequency and method of inspections to assure continued airworthiness as airplane structures age.

Under the program, manufacturers develop supplemental structural inspection documents which identify and describe structurally significant items, the type of potential damage to be addressed, likely damage sites and the damage tolerance ratings of the structurally significant items.

The documents recommend inspection methods, procedures and alternatives, inspection time thresholds and intervals. They also provide guidance to operators on how to perform the inspections. Thus, inspection documents amount to a revised maintenance reliability program for the airplanes.

Not all commercial airplanes, unfortunately, are under such a program, however, and manufacturers are still working to complete inspection documents on some models. Until all the inspection documents are complete, the continued airworthiness of these aging airplanes is being addressed through conventional service bulletins and airworthiness directives.

There is also a question or two about the program's ability to find problems before they become serious. About 3 months ago, fuselage frame cracks were discovered in the nose section of a Boeing 747 that was undergoing modifications. Three consecutive forward fuselage frames were found severed over the nosewheel well area.

In February, after an additional 12 airplanes had been found with cracks in the nose section the FAA issued a telegraphic AD to require inspection of this area. As of March 31st, 80 airplanes had been inspected for nose section cracks and half of them were found to have cracks. The longest was three-fourths of an inch.

Fatigue cracks also were found in stringers and stringer clips. According to the FAA, all of these airplanes are still capable of handling the ultimate loads for which they were designed. The FAA views the occurrence as a continued airworthiness problem to be controlled by ongoing maintenance and to a lesser extent by the inspection program.

It is important to note that the frames in question had not yet been scheduled for inspection under the program. FAA engineers say that the cracks ultimately would have been detected by this program.

What this indicates to me is that we must be alert to any signs that the additional protection envisioned from the supplemental inspection program may not be sufficient.

Now I would like to turn to the issue of aging airplane engines. A formal program of supplemental inspection for engines has not been developed by the FAA. The continued airworthiness of engines is addresed through maintenance reliability programs and the identification of problems in service.

This is in addition, of course, to the issuance of service bulletins and airworthiness directives. For the most part, turbojet engines have brought a new level of reliability to aviation. However, despite a history of solid, safe performance we are going through a period where the most widely used of these engines in the commercial airplane fleet, the Pratt & Whitney JT8D, has been experiencing some maintenance problems which are causing difficulties for the carriers, and not a little for the NTSB.

The JT8D was certificated in 1963. Production of the basic models of the engines 1-17AR was discontinued in 1985. Certain updated versions still are in production for the MD-80 series airplanes. There are about 12,000 engines in service on some 3,900 airplanes.

The engine teardown time was increased gradually, based on operating experience, from 1,400 hours in July of 1965 to 13,850 hours in June of 1971. Eventually, the requirement to tear down the engine in the specified time was eliminated and operators were permitted to tear

down and inspect the separate modules in specified times or when their condition warranted inspection.

The engine conditioning monitoring program now permits operators to overhaul only when the program indicates the need for an overhaul.

Some airlines have elected this for their system of maintenance reliability. Others continue to perform so-called "hot section" inspections and certain heavy maintenance on a hard time basis.

What has been the difficulty with the JT8D? Perhaps the most severe problems in terms of potential serious harm to the airplane is the failure of second stage turbine disk which not only can but does result in uncontained engine failure.

I should note that turbojet airplanes are designed to fly with the loss of an engine. Failures are expected to occur and redundancy is built in accordingly. However, uncontained failures can result in the release of engine parts which can cause serious structural damage to the plane.

To date, there have been seven turbine disk failures, all uncontained. In fact, there is some doubt as to whether a turbine disk failure can be contained or it will ever be. No warning is given in advance and these failures cannot be detected by an engine conditioning monitoring program.

Another significant JT8D problem is the failure of high-pressure compressor removable sleeve spacers. Failure of the spacers results from fatigue cracks. The only indication of a cracked spacer that might be detected by engine condition monitoring is the high-engine vibration. As with turbine disk ruptures, engine parts which might be ejected are capable of causing airplane damage.

This problem first occurred in the mid-1970s and to date there have been 47 spacer failures, of which eight have penetrated the engine cowling and one of the most recent was involved in the accident of a Midwest Express in Milwaukee on September 6 of last year, I believe.

Still another problem involves combustion chamber cracking which also potentially exposes the airplane to damage. This results primarily from improper maintenance and inspection, made worse by extended operating time and previous combustion chamber repairs.

Failure of a combustion chamber figured into the fire on the Boeing 737 at Manchester, England on August 22, 1985, which resulted in the death of 55 people. As a result, the FAA issued telegraphic airworthiness directives requiring inspection of these JT8Ds not operated under the engine conditioning monitoring programs.

The FAA published an NPRM in November of 1985 proposing additional inspections of the combustion chambers, including those being operated under teh ECM programs. The Safety Board agreed the action was urgently needed.

However, a later development led the Board to believe that the action was insufficient. This was an incident at LaGuardia Airport in February involving a combustion chamber failure on a Boeing 727. The circumstances of this incident suggest a deficiency in the monitoring program under which the engine was maintained, and in the FAA surveillance of the carrier's use of the engine condition monitoring programs.

Accordingly, the Safety Board recently sent new recommendations to the FAA. We called on the agency to require inspection of high time combustion chambers as soon as possible and to review the adequacy of the engine condition monitoring programs.

The Safety Board asked the FAA to develop minimum standards for these programs and to improve surveillance to justify them as a primary indicator of engine operating health.

There are several other problems mentioned in my formal statement, but at this point I think we would all be best served with a summation. The Safety Board is concerned in general that addressing each of these problems as they have arisen has resulted in a rather complex and unwieldy engine maintenance program which operators and repair facilities may find difficult to implement efficiently.

A a result, the Board in its most recent recommendations asked the FAA to convene a maintenance review board comprised of experts from Pratt & Whitney and maintenance overhaul facilities to review the JT8D engine maintenance program. The review would cover such areas as time limits on parts, inspection requirements, engine modifications and criteria for repair and replacement of aging componets.

As I mentioned earlier, there are no special requirements to address the continued airworthiness of aging engines analogous to the supplemental structure inspection program for aging airplanes. Despite the safe performance of the JT8D in the past, it is necessary now to look ahead to prevention of potential problems caused by aging.

The convening of a maintenance review board to review the programs under which aging engines are maintained could serve that purpose.

One sure way to reduce the failure frequency of aging engines and to assure the airworthiness of aging airplanes is to improve the effectiveness of the FAA surveillance of the system in which both are operated and maintained. We have advocated more and better FAA surveillance before in other forums and we repeat that message here.

That concludes my summary, Madam Chairman, and I would be pleased to respond to the questions of the committee.

Senator KASSEBAUM. Thank you, Chairman Burnett, for your very thoughtful testimony.

You mentioned the SSI program and the question of whether it is sufficient in light of the cracks that were found in the 747.

Do you have any recommendations on how to monitor the program or changes that should be made to this inspection program?

Mr. BURNETT. Dr. Loeb.

Dr. LOEB. What we need to be especially alert to is, first of all, the frequency of the inspections and second, the techniques used to perform the inspections. On the particular aircraft that we are talking about, these 747s, indeed this area of these airplanes would have been inspected, given enough time.

I believe that these inspections would most likely have been performed on the D checks. However, they would not have been scheduled for some period following the implementation of the SSID's.

When Boeing put their SSID program into effect, they gave the operators 1 year in which to get the programs going and then the inspections would begin.

However, not all of the inspections would have been performed during that 1 year. Some might not have been performed or 2 or 3 years afterwards.

Senator KASSEBAUM. Pardon me. Is this just because of the implementation as such and once it is fully implemented, it would be different?

Dr. LOEB. No. It is because of the time scheduling of the given inspections and the perceived time needed to detect the cracks prior to critical length. These airplanes were designed under the failsafe concept and that means that if the primary load carrying components failed, there is a secondary or failsafe load path to carry the ultimate loads.

The intent is that inspections should detect cracks in the secondary loads prior to failure of the airplane. That is the point of the program. In this particular case, we can ask if the scheduled inspections under the supplemental structural inspection program have detected cracking in the secondary load path in time?

In this particular case, the secondary load path would have been the airframe skin. Cracks would have been perceivable to the human eye. There would have been other indications such as noise from air escaping under pressure. It is likely that the cracks would have been detected, but we cannot say for sure, and certainly FAA surveillance of the inspection process is needed to ensure that this program will work.

Mr. BURNETT. It is quite possible, Madam Chairman, that these would have been detected by some carriers and unfortunately not by other carriers who had less rigorous programs. And of course that is our worry, especially in time of competitive aviation.

Senator KASSEBAUM. So you are saying that you believe frequency is a problem; that greater frequency is important and improved surveillance by the FAA?

Dr. LOEB. I believe frequency could be. I think it is one of the things we have to examine in the future.

Senator KASSEBAUM. And surveillance by the FAA?

Dr. LOEB. I think that is the key to the success of the supplemental structural inspection program and the ongoing continuous airworthiness progams. The key to the success is the FAA's surveillance of the operator's implementation of these programs.

As Chairman Burnett has said, undoubtedly there are carriers out there who will indeed implement these programs and probably be extremely successful in their undertaking, but there are other carriers that might not.

Senator KASSEBAUM. You expressed concern with corrosion in your testimony and that it may not be adequately addressed in the SSID program and suggest this requires monitoring.

What exactly do you mean by monitoring? How would this be done and do you have any specific recommendations regarding that?

Mr. BURNETT. The SSID program does not directly address corrosion. It is designed to detect fatigue cracking. Now, fortunately, corrosion most often results in some fatigue cracking in airplanes so there is a likelihood that the SSID program would resolve some of the corrosion programs.

The complicating factor we have with corrosion is that it is accelerated by environmental conditions so that if you have aircraft operating in salt air areas or carrying corrosive cargo as we have seen in some foreign accident investigations, or you have an area where sulfur is emitted into the atmosphere, you may have corrosion accelerated. So it is very much harder to predict time it would take for the corrosive process and that complicates trying to put it on a fixed inspection cycle basis because it may result in unduly repetitive inspections in some areas and maybe insufficient in others.

So I do not know that we have a good solution at this point.

Senator KASSEBAUM. But you would anticipate then, a need for expanded monitoring by the FAA?

Mr. BURNETT. Again, I think it is going to take very close inspection by the carriers, but the FAA is going to have to determine what they expect of the carriers based on the environmental circumstances under which the aircraft are being operated.

Did you have anything to add to that?

Senator KASSEBAUM. Dr. Loeb.

Dr. LOEB. Well, I think there is a possibility that over time we might find that there is a need for the supplemental inspection program to deal with the corrosion issue more directly Our main concerns are that corrosion that could exist in areas of the airplane structure that are extremely difficult to get to, areas in which you might have to peel the skin in order to inspect and detect, and if the corrosion is of a form which is not resulting in fatigue cracking, but rather pitting and decay of the material leading to failure of the structure from corrosion itself, it is much more difficult to detect.

So that is something that we are going to have to watch very closely to see if that is going to become a problem with the aging fleet.

Senator KASSEBAUM. You talked about the JT8D engine and its success over a period of time. However, some problems have occurred with that engine in the past, and yet there has been a real time lag in addressing some of the discrepancies that were raised. Why do you think this has happened and how can this be addressed?

Mr. BURNETT. Well, we did experience a time lag with the addressing of the removable sleeve spacers, and we tried to explore that issue with the FAA in our hearing on the Milwaukee accident. Unfortunately it is still not clear to me why we did not have some earlier response to the need to replace those spacers with the intergral sleeve spacers, even after they became available and carriers were advised that they should do that.

That is an area that, unfortunately, we were not able to get an adequate answer on. Perhaps it will be forthcoming during this hearing.

Senator KASSEBAUM. I would like to know why there not an airworthiness directive issued some time back as questions did occur about the JT8B. Do you have any answer for this?

Mr. BURNETT. No, I do not. I think that is the point. Once it was known, the carriers were advised and were being encouraged by Pratt & Whitney to replace them with the integral sleeve spacer; there was no airworthiness directive to require that they be replaced and consequently we have many that are still in service. In fact, it will still take at least 2 years to remove all of them and have them replaced, given the time it takes to manufacture them and to accomplish the replacements.

Senator KASSEBAUM. Could you describe just briefly your working relationship with FAA and if you have any suggestions for improving that relationship?

Mr. BURNETT. Well, I think basically, as I have said many times, we have a constructive relationship with the FAA; that does not mean it is always an easy relationship. We always say nice things about each other, though.

Senator FORD. It is kind of like a politician.

Mr. BURNETT. Well, I am, Senator. I will confess to that.

I think on this particular issue, we first became acquainted with JT8d spacer problems in an incident involving Northwest Orient Airlines in January 1985. We first experienced the spacer problem, in an accident in the Midwest Express crash at Milwaukee, at least that I am aware of. Dr. Loeb may correct me if I am mistaken on that.

So it was not an issue that the NTSB had gotten into at that time. Pratt & Whitney issued the first service bulletin. But certainly it seems to me that once Pratt & Whitney was at the point of advising the operators to replace the spacers, they should have done so, and if not it was incumbent upon the FAA to move forward with a directive requiring that it be done, so that the laggards in the industry would not place people's lives in danger and embarrass the whole industry, including those people who were more progressive and forthcoming.

Senator KASSEBAUM. You mentioned the Maintenance Review Board as something you believed would be important to set up and monitor engines, I assume the JT8d specifically.

Now, has not the FAA really put in place a very thorough inspection program?

Mr. BURNETT. We recently issued those recommendations to the FAA for a review of the problems, because many of these problems have come front and center within the last year. And there have been so many of them, all affecting the engine which provides most of us with air transportation, that obviously the FAA has been strained, as we have, in trying to respond to the problems as they have been developing. I am very appreciative of that situation, and we think that the carriers and the manufacturer have also been under a great strain in trying to respond to all of this.

We believe that the Maintenance Review Board would allow us to begin looking at this in a cohesive way trying to integrate these problems, rather than trying to respond to them individually into one

logical program that will be responsive to the problems that are developing.

Senator KASSEBAUM. Will this review board encompass airframe as well as engines?

Mr. BURNETT. No. I am just speaking of maintenance for the JT8D. I want to stress that we have not seen, at least up until the issues that arose out of the Japanese accident, airframe maintenance problems as being a major concern. Certainly it is an issue in that accident, and that is for the Japanese to determine. We issued recommendations based on our concern about the 747 problems that arose but certainly the engine maintenance problems have been more dramatically demonstrated to be a problem.

Senator KASSEBAUM. Thank you.

Senator Ford.

Senator FORD. Thank you, Madam Chairman.

Just a couple of questions, Chairman Burnett, as it relates to air charters. I am specifically interested in military, since the Gander accident affected my home State very harshly.

In the current FAA certification process of charters and the way the Department of Defense uses them, in your opinion, sufficien?

Mr. BURNETT. Senator, I know there has been legislation introduced, at least in the other body, that would require the DOD to do inspections of their own contract carriers. I am very much in favor of that legislation because I think the FAA's surveillance capability is stretched far beyond its ability to do the kind of job that I think needs to be done.

I would hope in this area, where I think the Armed Forces have a special responsibility, that they should assume part of the burden. What they have done in this case, as well as in surface transportation in other areas, is to try to throw upon the civilian agencies the responsibilities for carrying this out and the civilian agencies are simply not staffed to do their job at all. To the extent that we can get supplementary assistance from the Armed Forces, I believe that would be necessary.

Is that responsive to your question?

Senator FORD. Yes. But now, as we read about the Canadian investigation of the crash in Gander, it is kind of a cat and mouse game as you have just said. FAA thought the Department of Defense was overseeing, and the Department of Defense thought FAA was overseeing. So you are telling me that really—well, is there a basic responsibility for that under the statutes today?

Mr. BURNETT. Well, I think clearly under the statutes, responsibility falls to the FAA. Whether DOD has responsibility or not, since we do not interface with them so much, I do not know.

But despite that, I think that the FAA is really not staffed at this time to do all it needs to do. I would prefer not to see a great deal of their surveillance effort diverted to doing military contract surveillance when we have less than we need out there in normal scheduled air carrier operations. I would hope that some of that could be picked up, at least in the interim, and perhaps permanently by the DOD.

Senator FORD. What you are saying then is that you consider that the DOD has sufficient personnel or at least is in a better position than FAA to do this?

Mr. BURNETT. Well, they certainly have been expanded overall in times when the FAA has been somewhat cut back. Now, I wouldn't want to say that I think the DOD is better equipped to do that in terms of the skill of their personnel in doing inspections because I very much doubt that. The FAA people have been in that business.

But the fact is, we just do not have enough FAA people to go around, and I think that certainly DOD ought to be able to train some of their people to do that sort of thing, and they certainly have a lot of expertise in the area of aircraft safety. It is not in the general aircraft area of commercial type of operations, but I think it could be adapted to that.

Senator FORD. Well, it is disconcerting to me that everybody is beginning to fence and do whatever is necessary to try to relieve themselves of any kind of obligation. We always heard the statement, "I wouldn't take a night out on a dog like this," but apparently those who understood that an aircraft had crashed, had referred to it as a dog. If that was known within the maintenance and flight personnel, it appears that somebody else should have know that.

So, one, there was no inspection by FAA or recent inspection; two, the Department of Defense was saying they are certified, and so we take that and it is their responsibility, not ours.

So is that kind of the attitude? The attitude is there and the information is there. I am surprised that the pilots would fly those aircraft, based on their knowledge.

Mr. BURNETT. Well, Senator, I do not think the Safety Board has information at this time that would support that statement about that aircraft.

Senator FORD. Well, those who flew the aircraft.

Mr. BURNETT. I know the statement has been made to that effect.

Senator FORD. Like my grandfather said, all he knew is what he read in the paper. And that basically is all I know now, but I promise you I am going to look into this, because we lost too many lives in this particular operation. Yet, you continue down the same path.

I am of the opinion that there are enough military aircraft out there on training missions that could be scheduled to transfer some of these personnel, rather than contract it out. They say maybe it will cost more, but, in my opinion, it would be a lot safer under the circumstances.

Mr. BURNETT. I am not sure that that is true. I think well-surveilled and the best of the contract carriers may do a safer job of providing that transportation than the military would itself.

Senator FORD. Well, that is one hell of an indictment on the military, Mr. Burnett. And if you intended that, then I think you ought to substantiate that statement.

Mr. BURNETT. Well, I cannot.

Senator FORD. You cannot.

Mr. BURNETT. No, I cannot.

Senator FORD. Well, I would be careful with what I said, then.

Mr. BURNETT. Well, with respect to the military, I still say that it would not surprise me. They have been doing that, I guess, for many many years, using contract carriers, and I do not know that we would be in a position to recommend that they abandon that program.

Certainly there are certain areas of commercial type of operations and scheduled type of operations that the best of the commercial carriers may be better at than the military.

Senator FORD. Thank you, Madam Chairman.

Senator KASSEBAUM. Thank you.

Senator Exon.

Senator EXON. Madam Chairman, thank you very much.

I apologize to the Chairman and the members of the committee, my colleague from Kentucky, and certainly Mr. Burnett, for being delayed. There are lots of things going on this morning, as you can imagine, and we had a rather important meeting at the Armed Services Committee that I had to go to first.

I think there is no subject, though, that is more important right now than the need to address a partial breakdown of the overall safety of our airlines. Consistent with this is the subject of the aging aircraft fleet. I am interested in what your organization is doing on this issue, Mr Burnett, and I understand that you made a very good opening statement. I congratulate you for your aggressive posture in this. I think it is very timely, very timely indeed.

Let me ask this question. Fill me in, if you will, a little bit of the history of the Board on which you serve, the National Transportation Safety Board. What was the reason from the beginning for creating such a Safety Board?

I assumed, perhaps incorrectly, that the Safety Board was originally envisoned as an after-the-fact proposition. In other words, you would go in and examine after an accident happened, to determine whether or not—and what should be done to keep from repeating mistakes.

Is that accurate?

Mr. BURNETT. Yes, Senator. The inception of the Safety Board was to provide independent accident investigation after the accident so that the regulatory agency whose policies—not only the regulatory agency, but the agency that regulates and provides essential services to the air traffic system, which might be tempted to skew its findings in an accident investigation process—would not be investigating itself.

I think over the years, the value of having an independent accident investigation agency has been proved out many times. In addition, it very quickly became apparent that if you have an agency that does all of this accident investigation, that it ought to produce some sort of end product that would be useful for policymakers in the course of trying to remedy the problems that were identified.

So we were given responsibility for making safety recommendations, that all occurring when the accident investigation function was still in the Civil Aeronautics Board.

So that has been the historic role of the Board and its predecessor agencies for, I suppose, 40 years or 50 years now or more, going back I guess to the Hindenberg accident and before.

Senator EXON. In more recent times, while carrying out those activities that the Board was created for, have you not become more and more involved and are you not becoming more involved at the present time in recommending preventive actions before the accident occurs rather than just after-the-fact examination.

Mr. BURNETT. We tried to become more proactive; that is, anticipating problems. But still, our basic mandate is to investigate accidents, and we do best what we find in the course of accident and incident investigations. Over the last few years, the Board has become much more active in doing air carrier incident investigations in which we hope to use a happening that did not turn out as badly as it could have to identify problems before we actually had to pay for them in lost lives.

Even within our accident investigation responsibility, we put more and more attention now to those accidents that are not catastrophic but which may presage a catastrophic type of occurrence, rather than just being reactive to the types of accidents that the public immediately demands an answer to.

Senator EXON. Mr. Burnett, as Chairman of the National Transportation Safety Board, or even just as an individual very much concered about overall aviation safety, do you share my concern that there seems to have been a let-down, or there seems to be not as much preventive maintenance being done on the commercial airline fleet as there was prior to deregulation in 1978?

Is that fear that I have justified?

Mr. BURNETT. It is not clear that it is. I think that certainly we have to recognize that the temptation will be greater to cut corners by reducing maintenance activities now than it was under the less competitive environment. But it is not clear to me that maintenance is now being derogated.

We have had some very well-publicized incidents of investigations by the FAA into maintenance difficulties at some of the major airlines, but I am not sure that that reflects a lessening of the airlines' efforts as much as it does some increases and improvements in the FAA's efforts in that regard, which I think is highly called for and I think the Administrator is to be congratulated for initiating.

I think the FAA is beginning to realize that you have to have, in a very competitive environment, you have to have a tough referee, a refereee with a fast whistle, and they are responding to that. Unfortunately, they do not have the people that they need to have in order to do the kind of job that I think needs to be done in that regard, but I do think they are trying.

I have overall been more concerned with the operational side of the competitive environment than I have been with the maintenance side because I am satisfied that the FAA can handle the maintenance side with aggressive enough policies.

On the operational side, where they do not really have regulations in place to require the quality or the experience level of pilots at the levels that the air carriers themselves have traditionally operated, and where we see that the experience levels are going down very sharply and appear to meet the low levels that are only required by the regulations, is of more concern to me than the maintenance.

Nevertheless, I think we have to continue to look very hard at all accidents and incident situations to find evidence of whether or not maintenance programs are being made less effective.

Senator EXON. Are you suggesting that we should at least look at the proposition of whether additional legislation is necessary to give the FAA more authority than it has now in this area of surveillance?

Mr. BURNETT. I doubt that. I think that the FAA has very broad and very sufficient authority. I think to use that authority is another question and I believe that they are moving, very clearly and very dramatically, to a more aggressive posture in refereeing the maintenance situation in the competitive environment.

I think they were a little slow getting started because I do not think they really anticipated what was going to happen as a result of deregulation. But they have come up now against the limitations of their own staff resources, and they are moving to add additional inspectors. Unfortunately, probably the number that they are attempting to add this year is probably the number that they could assimilate so that they cannot do much more than they are doing right now, but I think they are a long way shy of what they need in terms of an inspection force.

I think the ranks of the FAA would agree with that.

Senator EXON. Are you concerned at all, Mr. Burnett, about what I continue to read about declining profit pictures of certain airlines?

I have used the analogy in the past, incorrectly or not, that if I were running a truck line and I was under extreme competitive pressures, and the balance sheet was getting thinner and thinner or I was operating at a loss—I am always fearful that I might, as a truck operator, drive those tires another 2,000 or 3,000 miles, or not do the costly routine maintenance work, in order to try and get to a place where I am breaking even and showing a profit.

In the truck industry, at least, if that would happen, the truck can pull off to the side of the road. That is not always the case with regard to airlines. Is that a concern of yours as a safety expert?

Mr. BURNETT. I think we have to be concered about it, Senator. I want to stress, however, that there is no clear evidence now that that is happening. In fact, to the extent that we have looked into—had the opportunity with, for instance, Part 35 carriers, to look into whether there is relationship between accident and incident rates and the financial health of the carrier, it cannot really be found.

So I think you have to assume that some time those carriers that are making profits may be making profits because they are cutting corners, but nevertheless the temptation exists when you are in a financial bind to make decisions that are unwise, when you would make decisions when you were not in a financial bind.

That is the reason that I think that carriers that are having problems, whether they are from marginal financial condition or labor unrest, these things need to be identified for special surveillance efforts to be sure that they are not responding to their crisis situation by violating the Federal regulations.

Senator EXON. We hear—maybe we have better communcations—maybe it is just something we are focusing on too much. I travel on airlines all the time and I frankly do not feel unsafe on airlines. I think that most of the airlines do a pretty good job, but I do get concerned when I see an extended price war, such as that which is going on today, with who can offer the lowest price from point A to point B, if you buy 30 days ahead of time you have one rate. In some cases you can go for $67 by just walking down to a ticket counter the day you want to travel and just get on an airplane.

Competition is a wonderful thing, and certainly deregulation has increased, I suggest, the use of airlines. That is pretty obvious. But it seems to me that those of us, including the regulators who have a definite responsibility to play here, have to be more vigilant than we have ever been before to make certain—I am sure certain that no one would do anything intentionally, but the profit and loss system and the free enterprise system is a great one from one standpoint. But unless we are very vigilant, it could end up not being so good from the standpoint of overall safety.

I just use an example.

Mr. BURNETT. Unfortunately, there are those who will do things intentionally and we have seen that in accident investigation scenarios. It is not characteristic of the industry. But I think the thing we have to anticipate is that if we have an unrefereed industry, if we allow competition without rules to protect the public safety, those people who are willing, intentionally or otherwise, to cut corners and to reduce the level of safety, are going to be able to out-compete in the short run at least, maybe not in the long run, but in the short run out-compete those who want to maintain the highest of stanards.

So the only solution, as you stated, is a very high level of vigilance. And that vigilance has to be not only maintained, but the resources have to be there to maintain it.

Senator EXON. Mr. Burnett, thank you very much.

Thank you, Madam Chairman.

Senator KASSEBAUM. Thank you very much, Chairman Burnett and Dr. Loeb. I appreciate your very fine testimony.

Mr. BURNETT. Thank you and thank you for these hearings.

[The statement follows:]

STATEMENT OF JIM BURNETT, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD

Madame Chairman, members of the Subcommittee, I welcome the opportunity to be here today to share the Safety Board's views on aging of commercial airplanes. Before I begin my formal testimony I would like to introduce Dr. Bernard S. Loeb, Chief, Aviation Engineering Division, who is with me at the table.

The system of inspection and maintenance for ensuring the safety of the fleet as it ages has been basically sound thus far. Nonetheless, we do not want success in aviation safety over the years to dull our senses to the awesome dangers that come about from lapses in surveillance or acceptance of the status quo.

Airplanes are designed, certificated and manufactured in accordance with Federal Aviation Regulations (FARs) to provide many years of useful service. An evaluation of the strength, detail design and fabrication of the principal parts of most transport category airplanes in service today was performed by the manufacturer to demonstrate, in accordance with the fail-safe (or in some cases the safe-life) design concept, that they would not fail catastrophically from fatigue or corrosion damage. (Airplanes are designed with the presumption that they will sustain such damage during their service life.)

The fail-safe concept requires that in the event a principal structural component (a primary load carrying item) fails, the secondary or fail-safe load path, which will carry the redistributed load, has sufficient residual strength to support the ultimate loads expected. The safe-life concept requires that the structural component or part will not fail when subjected to the ultimate loads or that it will not fail within a specified period of time.

In 1978, the regulations were revised to require, except where impractical, the damage-tolerance of the airplane structure. Under this concept the manufacturer must determine the probable location and modes of damage from fatigue, corrosion or accidental damage, including damage at multiple sites from prior fatigue exposure. Evaluations must show that sufficient residual strength exists following damage of a component to permit the damage to be detected by inspection prior to failure of the part.

For an airplane to continue in an airworthy condition once it enters service, it must be operated, inspection and maintained in accordance with an FAA-approved maintenance reliability program developed through a Maintenance Review Board composed of representatives of the FAA, the manufacturer and operators.

Operating experience has shown that as airplanes become older they will require more frequent inspection of their structures for damge from fatigue and corrosion. This is because fatigue is flight-cycle dependent and corrosion is time dependent. The longer the airplane is in service and the more takeoffs and landings to which it is subjected, the greater is the effect of factors such as fatigue cracking and corrosion on the structural integrity of the airplane.

This is especially so for corrosion, which is highly dependent upon the environment in which the airplane is operated. Airplanes operated near salt air or sulphur producing industry develop corrosion problems before they reach the fatigue limits of their structures. Thus, the extended use of airplanes could result in greater risk to the public if these airplanes are not adequately inspected and maintained.

However, with adequate inspection and maintenance the extended use of airplanes should not result in a degradation in safety. The key question then is, what is adequate? This is not easy to answer, but we should not assume that the frequency and type of inspections adequate in the early stages of an airplane's life will remain adequate as the airplane ages.

Federal regulations do not address directly the age of airplanes. Neither do they require a manufacturer to determine or estimate the fatigue life or safe life for an entire airplane or its airframe. Manufacturers generally design planes to have a specific economic life during which airframes should not develop major fatigue cracks. It is important to bear in mind that this economic design fatigue life of an airplane is not based primarily on safety considerations.

Essentially, the design philosophy is that an airplane can be used forever provided continuing inspections show that the structure is not damaged by fatigue or corrosion. Safety is addressed through establishment of various inspections and maintenance reliability programs.

A question—one of many I will raise here today—is whether or to what extent the continuing inspection program is able to assure the detection of problems which might develop as the airplane approaches and passes the economic design life criteria.

The Safety Board has investigated or participated in the investigation of many accidents and incidents in which airplanes experienced failures in their structure,

flight control surfaces and landing gear because of fatigue cracks or corrosion. These occurrences include:

—Decompression of a Boeing 707/720 because of cracks in the fuselage sidewall, flap failures and a horizontal stabilizer failure.

—Depressurization of a Boeing 727 because of fatigue cracks in a floor beam flange; numerous other fatigue cracks and corrosion failures of landing gear components.

—The Boeing 747 has experienced a rear pressure bulkhead failure and fuselage cracks in the nose section, which I will discuss in futher detail later.

In all, Safety Board data reveal that for the last 15 years fatigue or corrosion has been mentioned as a probable cause or related factor in 35 of the 554 air carrier accidents which occurred during that period. These accidents included older propeller driven airplanes, tuboprop airplanes and the more modern turbojet airplanes. Fatigue or corrosion was also mentioned 77 times during that period in 579 such air carrier incidents.

However, few of these accidents or incidents involved fatigue cracking or corrosion of the primary structure of turbojet transport airplanes. Further, there has not been one passenger fatality from an aviation accident in the U.S. in which the Safety Board has cited fatigue or corrosion in a tubojet transport as a cause or related factor.

None of these occurrences has been attributed to age, per se. Most have resulted from inadequate or improper inspection or maintenance. Others were attributed to inadequate design. However, some of these did involve relatively high time airplanes.

It is possible that had the high time planes been subjected to more frequent inspections the fatigue cracks would have been detected?

We certainly hope so, but it is an open question. Why? The FAA program to ensure against this happening has not been fully implemented, nor is its coverage yet as broad as it might be.

The FAA's program to determine which components of the older turbojet airplanes designed under the fail-safe concept require more frequent inspection for fatigue is called the Supplemental Structural Inspection Program for large transport category airplanes. It is designed to adjust the frequency and method of inspections to assure continued airworthiness as airplane structures age. In essence, the program provides special attention to areas of the airplane not necessarily found to be of concern during the original structural analysis, as well as to areas which experience service difficulties—all to ensure contained structural integrity.

Under the program, manufacturers develop Supplemental Structural Inspection Documents (SSID) which, among other things, identify and describe structurally significant items, the type of potential damage to be addressed, likely damage sites and the damage tolerance ratings of the structurally significant items. The documents recommend inspection methods, procedures and alternatives, inspection time thresholds and intervals. They also provide guidance to operators on how to perform the inspections. Thus, the inspection documents amount to a revised maintenance reliability program for the airplane.

The program has produced results. Through it, Boeing has identified significant structural items on the B-727, 737 and 747 that will require additional inspections as the airplanes age. Thus, the Supplemental Structural Inspection Program should provide protection against catastrophic loss of older planes from the fatigue failure of critical parts or components. However, not all commercial airplanes are under such a program.

To date, Boeing has developed Supplemental Structural Inspection Documents for the 707, 720, 727 and 747 models. McDonnell Douglas has completed a supplemental inspection document for the DC-8 which was approved by FAA last February 28. The company is scheduled to complete its document on the DC-9-30 by June 1986; on the DC-9-10 by June 1987 and on the DC-9-40/50 and the DC-10 by June 1988.

Lockhead has a target of March 1987 to complete a supplemental inspection document for the L-1011.

Until all the inspection documents are complete, the continued airworthiness of these aging airplanes is being addressed through conventional service bulletins and airworthiness directives.

How about older, non-jet airplanes? Aging Convairs, Electras and the DC-3s probably undergo less strigent inspection programs than would have been required if specific supplemental inspection procedures had been developed for these airplanes.

The Board would feel more comfortable knowing that the added safety protection of the Supplemental Structural Inspection Program covered the entire commercial, airplane fleet. Shouldn't that be the goal?

Let me raise another question about the Supplemental Structural Inspection Program. Can it adequately detect corrosion?

Boeing's supplemental inspection documents do not directly address the issue of corrosion, rather just fatigue cracking. Boeing holds that the more general problem of corrosion is properly handled through continuing maintenance of the airplane and not through the supplemental inspection program. FAA appears to agree. However, corrosion problems are treated indirectly in that most often corrosion in airplanes is reflected in fatigue cracks.

Should this be the case? I submit the answer is unclear. The Safety Board believes this requires monitoring to make sure that corrosion in older airplanes will be properly addressed.

Another question of special interest to us involves the use by Boeing of the "candidate airplane" concept for the supplemental inspection program. Under this concept, all Boeing airplanes with a specified number of flight cycles on a given date—other than the 707/720 models—were selected for supplemental inspections. Significant cracks identified through these inspections result in service bulletins and airworthiness directive by FAA which are applicable to all such airplanes.

Is the Boeing candidate fleet sufficiently large and inclusive? Can it accurately provide sufficient warning of the existence of previously undetected fatigue cracks so that fleetwide inspections can be instituted before any failures occur?

The concept of using a sampling process to detect fatigue cracks and to determine the need for inspections is not new. However, we believe the jury is out on both questions, and a special eye on the situation is needed.

There is also a question or two about the program's ability to find problems before they become serious.

About three months ago, fuselage frame cracks which I mentioned earlier were discovered in the nose section of a B–747 that was undergoing modifications. Three consecutive foward fuselage frames were found severed over the nose wheel well area. In February, after an additional 12 airplanes had been found with cracks in the nose section, the FAA issued a telegraphic AD to require inspection of this area. As of March 31, 80 airplanes have been inspected for nose section cracks and half were found to have them. The longest was ¾ of an inch. Fatigue cracks also were found in stringers and stringer clips. All of these planes are still capable of handling the ultimate loads for which they were designed, according to FAA.

The FAA views the occurrence as a continued airworthiness problem to be controlled by ongoing maintenance and to a lesser extent by the Supplemental Structural Inspection Program. It is important to note that the frames in question had not yet been scheduled for inspection under the Supplemental Inspection Program. FAA engineers say that the cracks would ultimately have been detected by this program.

Although none had progressed to the point of safety being compromised, the manufacturer is developing long-term solutions which will probably involve material changes, heavier gauges of material or additional doubler plates. We understand that changes will be incorporated on production planes and offered to operators as a retrofit to existing airframes.

All of this tells me that we must be alert to any signs that the additional protection envisioned from the supplemental inspection program may not be sufficient.

Still another question: what about cracks originating in areas of the plane that are not accessible without removal of its skin? Structural failure resulting from fatigue cracks originating on unaccessible but structurally significant parts or components and from corrosion of such parts can cause catastrophic structural failure to a plane as surely as fatigue cracks of accessible parts under the supplemental program.

Now let me turn to the issue of aging airplane engines.

A formal program of supplemental inspection for engines has not been developed by the FAA. The continued airworthiness of engines is addressed through maintenance reliability programs and the identification of problems in service, as well as the issuance of service bulletins by the manufacturers and airworthiness directives by the FAA.

For the most part, turbojet engines have brought a new level of reliability to aviation. However, despite a history of solid, safe performance, we are going through a period where the most widely used of these engines in the commerical airplane fleet—the Pratt and Whitney JT8D—has been experiencing some maintenance problems which are causing difficulties for the carriers.

The history of the JT8D–1 through 17AR engine provides some insight into the current process and difficulties in maintaining aging engines.

The JT8D was designed in 1960 and certificated in 1963; production of the basic models of the engines 1 through 17AR was discontinued in 1985. Certain updated versions—JT8D–200 models—still are in production for the MD–80 series airplanes. There are about 12,000 engines in service on some 3,900 airplanes.

The engine teardown time was increased gradually, based on operating experience, from 1,400 hours in July 1964 to 13,850 hours in June 1971. Eventually the requirement to treardown the engine in a specified time was eliminated and operators were permitted to teardown and inspect the separate modules at specified times or when the condition warranted inspection. Engine Condition Monitoring (ECM) now permits operators to overhaul only when the ECM program indicates the need for an overhaul.

Some airlines have elected this for their system of maintanence reliability. Others continue to perform so-called hot section inspections and certain heavy maintenance on a hard time basis.

What has been the difficulty with the JT8D?

Perhaps the most severe JT8D problem, in terms of potential serious harm to the airplane, is the failure of second stage turbine disks, which can result in uncontained engine failure. I should note here that turbojet airplanes are designed to fly with the loss of an engine; failures are expected to occur and redundancy is built in accordingly. However, uncontained failures can result in the release of engine parts which can cause serious structural damage to the plane. To date, there have been seven turbine disk failures. No warning is given in advance and these failures cannot be detected by an engine condition monitoring program.

In July 1985, after an accident involving a Saudi Arabian B–737, the Safety Board issued a recommendation that the FAA address this problem. The FAA subsequently did so in an Airworthiness Directive.

Another significant JT8D problem is the failure of high pressure compressor removable sleeve spacers. Spacer failures result from fatigue cracks. The only indication of a cracked spacer that might be detected by engine condition monitoring is high engine vibration.

As with turbine disk ruptures, engine parts which might be ejected are capable of causing airplane damage. This problem first occurred in the mid-1970s, and to date there have been 47 spacer failures, of which eight have penetrated the engine cowling.

On November 8, 1985 the Safety Board issued recommendations after the investigation of the fatal crash in Milwaukee of a DC–9 on September 6, 1985 revealed that a high pressure compressor removable sleeve spacer had ruptured.

The Safety Board recommended that the FAA require removal of all six spacers in the compressor. We said they should be replaced with integral sleeve spacers as soon as practical, but not later than the next time the engine was in a facility in which the maintenance could be done.

On January 2, 1986 the FAA proposed an Airworthiness Directive requiring inspection and replacement of certain removable spacers according to a specified schedule.

In commenting on the proposal, the Safety Board repeated that these spacers be replaced as soon as practical, but no later than 4,000 cycles time-in-service from the effective date of the directive. We recently have recommended that inspections be performed every 1,000 cycles until the spacers are replaced.

Another JT8D problem involves combustion chamber cracking, which also potentically exposes the airplane to damage. This results primarily from improper maintenance and inspection made worse by extended operating time and previous combustion chamber repairs. Failure of a combustion chamber figured into the crash of the B–737 at Manchester, England on August 22, 1985 which resulted in the death of 55 persons.

As a result, the FAA issued telegraphic Airworthiness Directives requiring inspection of those JT8Ds not operated under the Engine Condition Monitoring Program. On November 8, 1985 FAA published an NPRM proposing additional inspections of the combustion chambers, including those being operated under the ECM programs. The Safety Board agreed the action was urgently needed.

However, a later development led the Board to believe that the action was insufficient. This was an incident at LaGuardia Airport on February 6, 1986 involving a combustion chamber failure on a Boeing 727, which fortunately did not threaten the airplane. The circumstances of this incident suggests a deficiency in the ECM program under which the engine was maintained, and in the FAA surveillance of the carriers' use of the ECM Programs.

Accordingly, the Safety Board recently sent new recommendations to the FAA. We called on the agency to require inspection of high time combustion chambers as

soon as possible and to review the adequate of the Engine Conditions Monitoring programs.

The Safety Board asked the FAA to develop minimum standards for these programs and to improve surveillance to justify them as a primary indicator of engine operating health.

Still another JT8D problem has been failures in combustion chamber outercases from fatigue cracks or other diffiiculties. Some 35 incidents of these are known. Such failures also can result in airplane damage. Some of the outercase failures result from fatigue cracks which originate either at the outercase rear flange or at the drain boss or pressure tap weldments. These failures have occurred only on engines with more than 25,000 operating hours. However, rupture of the combustion chambers permitting high temperature gases to impinge on the outercase has also caused outercase failure.

The Safety Board has registered concern with the FAA about these fatigue cracks. The FAA has issued a final rule but it addresses only the cracks originating at the outercase flanges. The Board is preparing new comments on the rule to say that not only are new and better inspections needed, but that fatigue cracks originating in outercasing locations should be addressed too.

The JT8D has still other problems. There have been failures of second-stage fan blades, failures of high and low pressure turbine blades and internal engine fires.

Because of the number and significance of these failures, the FAA has devoted considerable time and resources to develop and publish rulemakings to address these problems, and has had difficulties in expeditiously developing and processing effective action. The air carriers are also experiencing problems in scheduling and implementing the numerous inspections, repairs and parts replacements imposed on them by the proliferation of service bulletins and ADs. The carriers contend that there is a lack of inspection equipment, overhaul facilities and replacement parts and that the logistics of scheduling the required actions provides serious difficulties for them.

The Safety Board is concerned that addressing each of these problems as they have arisen has resulted in a rather complex and unwieldy engine maintenance program with operators and repair facilities may find difficult to implement effectively.

As a result, the Board in its most recent recommendations asked the FAA to convene a maintenance review board comprised of experts from Pratt & Whitney and maintenance overhaul facilities to review the JT8D–1 through 17AE engine maintenance program. The review would cover such areas as time limits on parts, inspection requirements, engine modifications and criteria for repair and replacement of aging components.

As I mentioned earlier, there are no special requirements to address the continued airworthiness of aging engines analogous to the Supplemental Structure Inspection Program for aging airplanes. Despite the safe performance of the JT8D in the past, it is necessary to look ahead to prevention of potential problems caused by aging.

The convening of a maintenance review board to review the programs under which aging engines are maintained could serve that purpose.

One sure way to reduce the failure frequency of aging engines and to assure the airworthiness of aging airplanes is to improve the effectiveness of the FAA's surveillance of the system in which both are operated and maintained.

We have advocated more and better FAA surveillance before in other forums, and we repeat that message here.

Proper inspection and maintenance is the key to continued airworthiness of aging airplanes and engines. Proper FAA surveillance of the implementation by airplane operators of their maintenance reliability programs is the key to the proper inspection and maintenance of the aging fleet.

Madame Chairman, that concludes my formal statement. I would be pleased to respond to questions.

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### Questions of Senator Exon and the Answers

*Question.* You raise a number of issues in your testimony generally relating to the question of whether we are doing enough to ensure the safe operation of aging aircraft. In your mind, can we do better? If so, what can the FAA do to improve its role? The airlines? The manufacturers?

Answer. Yes, we can always do better. Complacency is a sure path to the deterioration of safety. However, on a practical basis, the airlines must inspect their airplanes in accordance with scheduled maintenance and supplemental structural in-

spection programs. Structural problems found during these inspections must then be communicated to the airframe/engine manufacturers, the FAA, other airlines, overhaul facilities, and parts manufacturers so that appropriate repair and replacement actions can be devised and implemented. Therefore, the key to the successful operation of aging aircraft is the FAA's monitoring and surveillance of the airlines implementation of these programs because the FAA must also approve major repair and replacemet actions. Through proper monitoring and surveillance, the FAA should learn of potential deficiencies in structurally significant parts and in the inspection and maintenance processes sufficiently early to implement corrective actions before catastrophic failures of aircraft or engines can occur.

*Question.* Do you have any estimates as to what extent the U.S. commercial air carrier fleet has reached and surpassed the originally-estimated design life?

Answer. Very few commercial jet transport airplanes now in service have reached the economic design life set by the manufacturers. For example, less than ten percent of Boeing 707 and 720 aircraft, and on the order of one percent or less of Boeing 727, 737, and 747 aircraft exceed their economic design life. Thre are, however, a number of older piston-powered airplanes that have now exceeded their originally conceived design lives.

*Question.* In my mind, the bottom line on aging aircraft is the need for maintenance. Are you seeing any reduction in the amount of maintenance performed by the airlines with respect to their aircraft, whether they be new or older airplanes?

Answer. Certain'v, there exist particular cases where even major carriers have not performed maintenance to the extent that they should. However, this is not a new phenomenon. The Safety Board has discussed such problems in accident reports and has made recommendations to the FAA to address such problems. Examples are the American Airlines use of an unapproved maintenance process which resulted in the crash of a DC–10 and the improper maintenance supervision by Eastern Airlines which resulted in the three-engine flameout of an L–1011. The Safety Board is concerned that, among some of the new entrants to the air carrier field, there may be some carriers that might not maintain their airplanes as they should. However, the Safety Board is not aware of any compelling evidence which indicates that air carriers are reducing the level of maintenance on their airplanes.

*Question.* At the end of your statement, you highlight the need for continued FAA surveillance of airline maintenance. Is the FAA doing an adequate job of fulfilling their monitoring responsibilities? Does the FAA have an adequate number of maintenance inspectors to adequately do the job of overseeing airline maintenance? Have they received adequate training?

Answer. The FAA is attempting to improve its surveillance of air carriers, although it still does not have a sufficient number of inspectors. The expected increase in inspectors will help; however, this will not be sufficient to do all the FAA needs to do. The FAA already has begun to improve its inspector training, and has developed a long term program to improve the quality of its surveillance activities. The issue now is whether this program will be put into practice given the effects of budget reduction efforts. The Safety Board recently began a program to monitor and review the FAA's implementation of its improved surveillance program to make a determination about its effectiveness.

*Question.* One particular problem I have with deregulation is the continuation of self-compliance to ensure adquate maintenance in the airline industry. Mr. Burnett, do you believe that an adequate job of aircraft maintenance is currently being performed, even with the minimal FAA involvement, or should we reconsider requiring only occasional surveillance of the industry's maintenance procedures?

Answer. In general, the system works fairly well. It is possible, perhaps likely, that elimination of the self-compliance aspects of the airworthiness system would improve the process somewhat. However, this would require an enormous increase in the staffing of the FAA's inspector force, and it is not clear that the improvements would be sufficient to warrant that extensive a change. The fact is, the system works reasonably well now and can be made to work even better without such a significant change.

*Question.* Are there particular U.S. airlines that rely on older aircraft to a greater extent than others? If so, which ones?

Answer. The older commercial jet transport airplanes are used by a large number of airlines. However, it does appear that these older airplanes tend to be used more extensively by some of the newer and smaller regional airlines. The even older piston- and turboprop-powered airplanes are almost exclusively used by the smaller airlines and charter operators.

*Question.* Several of the U.S. airlines are currently contracting their aircraft maintenance to outside groups. Do you see any problems with this approach? Is

there a different approach taken by the FAA with respect to ensuring adequate maintenance at these carriers? Do you believe that that approach is adequate?

Answer. The concept of an airline contracting its aircraft maintenance to an outside certificated repair facility should not pose a compromise to the safety and reliability of the airline's aircraft. However, a concern associated with the use of an outside repair facility is the loss of close coordination and communication between the airline and the contractor to ensure that the maintenance program of the contractor is suited to the manner in which the airline uses the aircraft. Currently, the outside repair facilities performing aircraft maintenance are controlled by the same FAA maintenance regulations used by airlines that maintain their own fleet of aircraft. With the exception of isolated incidents related to a breakdown in coordination between the airline and a contractor, this seems to be an adequate approach taken by the FAA. Again, however, appropriate surveillance of the airlines and its maintenance contractor must be performed by the FAA to verify that the contract maintenance is accomplished properly.

*Question.* The current flow of information on maintaining aircraft structure and engine safety is a loosely worked network that includes the Federal Aviation Administration, the manufacturers and the airlines operating the aircraft. Do you believe this informal network is sufficient to ensure the most up-to-date flow of information about aircraft operational problems? Should the process become more formalized by the FAA?

Answer. The Safety Board has not been satisfied with the flow of information on inspection and maintenance difficulties among the airlines, the manufacturers, and the FAA and has made a number of recommendations to the FAA to improve the process. Following its investigation into the crash of the American Airlines DD-10 at Chicago in May 1979, the Safety Board asked the FAA to require certain procedures to improve the availability and exchange of information regarding maintenance. One proposed procedures was to require repair facilities to perform a hazard analysis evaluation before changing an established maintenance practice specified by manufacturers, and to include the evaluation results along with the proposed changes to the FAA for approval. Among other procedures recommended by the Safety Board was a procedure for operators to report to the FAA all damage to structurally significant items. Also, we asked the FAA to better define major and minor repairs in order to improve the reporting of repair damage. The Safety Board also recommended that the FAA improve its surveillance of manufacturers quality control programs and their service difficulty and service information collection and dissemination system.

Following its investigation of the incident in which an Eastern Airlines L-1011 sustained a flameout of all three engines in May 1983, the Safety Board recommended that the FAA provide their air carrier inspectors with improved trend information based on maintenance data reported by airlines.

The FAA failed to complay with many of these recommendations, five of which (A-70-100 through -104) were issued as a result of the DC-10 accident at Chicago in 1979. The recommendations addressed collection, analysis and dissemination by maintenance facilities and airplane operators of information on damage to structurally significant components, especially damage associated with maintenance processes; the performance of hazard analyses by maintenance facilities and the Maintenance Review Board of maintenance practices which effect structurally significant components; and the classificaiton of the terms "major" and "minor" repairs (in 14 CFR 121.707) to ensure proper reporting of repair damage to structurally significant components. However, it indicated thta it is attempting to improve its data banks, including its service difficulty reporting system, and to provide trend analysis data for its inspectors to use in their surveillance of air carriers. Much of the work is being done under the auspecies of the Aviation Safety Analysis System (ASAS), but it is the Safety Board's understanding that full or even partial implementation of the system is years away.

Senator KASSEBAUM. Our next witness is Mr. Anthony Broderick, Associate Administrator for Aviation Standards, Federal Aviation Administration. Welcome.

First let me say, Mr. Broderick, I think a clear responsibility we have in the Congress and I am sure Senator Exon joins me in this, is making sure that the money is available to support the efforts of the FAA and the NTSB to meet the requirements for the aviation and transportation and safety efforts that you have to assume.

It has not always been easy to make sure that funding is available and I think it is one of the top priorities that we have here in assisting you.

**STATEMENT OF ANTHONY BRODERICK, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS, FEDERAL AVIATION ADMINISTRATION; ACCOMPANIED BY JAY J. PARDEE, MANAGER, ENGINEERING CERTIFICATION OFFICE; AND OWEN SCHROEDER, CERTIFICATION ENGINEER.**

Mr. BRODERICK. Thank you very much, Madam Chairman.

Madam Chairman, Senator Exon, I welcome the opportunity to appear before the subcommittee today to discuss both the FAA's process for certification of charter air carrier operators and the subject of aging aircraft in the air carrier fleet.

With me today on my left is Jay Pardee. Jay is a certification engineer and the Manager of the Engine Certification Office in New England Region near Boston. On my right is Owen Schroeder, a Certification Engineer with the Transport Aircraft Certification Director of the FAA in Seattle, Washington.

Madam Chairman, our subjects are important issues which warrant the continued interest of all within the aviation community. What I would like to do is briefly read the statement on the subject of aging aircraft and submit for the record the remainder of my statement on the certification of air carrier operators and, of course, answer any questions you may have on both issues at that same time.

The subject of aging aircraft in the nation's air carrier fleet is one we have been concerned with and have aggressively been addressing for some time now in cooperation with both manufacturers and the airlines.

It is readily apparent that, as the age of individual aircraft used in the fleet continues to increase, the opportunities for corrosion or fatigue of critical components of those aircraft likewise increase.

Therefore, the challenge which has faced us along with manufacturers and operators has been to develop design standards which reduce the likelihood of catastrophic failure, prescribe inspection intervals which will enable cracks or corrosion to be detected prior to the onset of failures of critical components, and monitor service history of aircraft, not only as a means of improving our design standards and refining inspection intervals, but to permit the timely correction of potential problems by the issuance of regulatory airworthiness directives, or ADs as we call them.

We have continued to improve upon our ability to achieve these important objectives.

In the early 1950s the standards relied upon careful detailed design to prevent the failure of key aircraft components by fatigue. Under this approach, we depended upon a maintenance program developed on the basis of previous transport service experience. "Hard time" inspection programs were used.

Before the advent of the jet age in the late 1950s the FAA developed standards which permitted either a safe life or a failsafe approach to design for fatigue. Under the safe life approach there was a required scheduled replacement of a part in accordance with the expected life of the part. The aircraft was simply retired from service when it became impractical to replace a part such as a wing or fusilage.

Starting with the Boeing 707, the failsafe approach was applied in the design of all U.S. commercial jets. Parts were constructed with a built-in redundancy under the premise that the aircraft could operate safely with an undetected flaw until the next scheduled inspection could correct it.

Under this philosophy, aircraft are designed so that the rate of crack lengthening will not reach a critical stage prior to the next scheduled inspection or maintenance. Manufacturers were called upon to recommend maintenance and inspection schedules based on test data at the time a new aircraft was introduced into service.

Changes to the maintenance and inspection schedules could be improved for individual airlines if they could demonstrate that the changes to the maintenance program would also provide a comparable level of safety. In that respect, I would note that the fatigue life expectancy of a structure could only be finally determined after many years of operation, so service history is a critical aspect of validating assumptions made during the design process and an assuring that aircraft continue to be airworthy.

In 1978, the FAA introduced a newer design concept for newly certificated aircraft which is called damage tolerance. A structure using the damage tolerance concept is one which has been designed to tolerate damage due to fatigue, corrosion, or accidental damage, and to continue to carry expected operational loads until detected either by the problem becoming evident or during a scheduled inspection.

Scheduled inspections of such components are based on a computer analysis of the crack growth characteristics called fracture mechanics of the part, and are designed to detect any crack before it reaches unsafe proportions. In other words, under the damage tolerance approach, we assume that damage will occur to a part from any of a number of possible conditions, including poor maintenance practices.

That part must then be designed to safely accommodate that damage until it can be corrected. The safe life approach may continue to be used for aircraft components on newly certificated aircraft to the extent that damage tolerance is not appropriate. One example where the safe life approach is used, that is, a specific life limit is placed on the component, is for landing gear.

We believe damage tolerance will provide improvements in aircraft design for future aircraft, but it did not apply directly to the vast majority of the aircraft in the current air carrier fleet, because they were certificated and built prior to our adoption of the damage tolerance rule in 1978.

Therefore, to address on a more current basis the need to assure that fatigue and corrosion were detected on aircraft currently in the fleet, the FAA issued guidance information to industry which outlines methods, including fracture mechanics assessment, to assure safety of older airplanes through additional structural inspections.

The number and extent of these additional structural inspections are based on an engineering analysis that assumes the existence of a crack at all critical locations and determines its growth rate and the point at which that crack would make the part unsafe. This approach, which we finalized in concert with industry in 1981, is called the supplemental structural inspection documents or SSID program.

Under SSID, manufacturers are asked to identify all structural components whose failures could affect the safety of the aircraft and to establish a special inspection program for these components. To date, SSIDs have been developed for the 707, 727, 737, and 747. The FAA has taken regulatory action to require the airlines to adhere to the schedules called for in these SSIDs.

We expect to see SSIDs developed for the DC-9, -10, -30, -40, -50, and the DC-10 and the L-1011 within approximately the next 2–2½ years, and would anticipate appropriate regulatory action to require compliance with their terms as well. The DC-8 and BAC-111 have SSIDs which have not yet been established as mandatory by the FAA, but will be shortly.

In terms of the issue of aging aircraft, I believe it is important to note that we are not experiencing a degradation of safety in commercial aviation, and that there is not cause for alarm. Clearly, the situation is one that merits attention and continued action on our part. Significantly, we have established an overall system in which all parties have an important role, and in which all parties must fulfill their functions responsibly and with the safety of the traveling public foremost in their minds.

The FAA, in addition to prescribing the appropriate regulatory framework and developing pertinent guidance material for use by industry will continue to monitor the way in which all elements of this cooperative system are meeting their obligations.

I would like to submit the rest of my statement for the record, Madam Chairman, and I would be happy to answer any questions you may have.

Senator KASSEBAUM. Thank you very much, Mr. Broderick.

First, let me ask a question for Senator Ford. Has the FAA taken any steps to review certified charter carriers? Your statement reviews the certification of new charter air carriers. Does the FAA conduct spot checks on certified charter carriers?

Mr. BRODERICK. Certified charter carriers that operate for the military are treated by us in the same manner as all the other carriers that we deal with. We require them to meet the same very high standards of safety that we require any airline to meet, and in fact they are representative of the airlines that the general public uses today.

We have initiated 2 or 3 months ago a special focus inspection, we call it, of all the smaller military charter operators, that is, the ones that are of the size of carriers like Arrow, Tower, carriers like that, smaller in the sense that they are at the smaller end of the spectrum of sizes of airlines.

That inspection is nearing completion, and we will have reviewed in depth the operations and maintenance programs of all of those carriers individually. The larger carriers were not singled out in that inspection, because we have another program called the National Inspection Program which on a 2- or 3-year cycle beginning just last fall is inspecting in-depth the operations and maintenance, programs of every airline in the country.

Really, what we did with the military charters was to bring those inspections up to the front of that program. We will continue to oversee them in the future, both as part of our normal surveillance and as part of our in-depth inspections of all airlines in the country.

Senator KASSEBAUM. How would you respond to Chairman Burnett's suggestion that the Department of Defense take over the responsibility for surveillance of the charters that they are using?

Mr. BRODERICK. I, too, am aware of that legislation which has been introduced in the House, and we are reviewing it and will establish a departmental position, so I do not have a formal official position yet, but I can say that as I indicated earlier, a military charter operator is an airline. If an airline has a safety problem, we in the FAA want to find out about that safety problem as soon as possible and correct it, whether or not an airline happens to be operating military charters.

All of the military charter airlines, as we call them, are actually only doing a minority, by military regulation, of their business with the military. The vast majority of their business is done with the civilian public, and for that reason I see no way in the world that we could tolerate any kind of safety noncompliance on the part of those carriers.

Senator KASSEBAUM. Let me ask a couple of questions, and then turn to Senator Exon.

According to a *Los Angeles Times* article that was extensive on aging fleet questions, from 1980 to 1984, service difficulty reports declined except for the 747 and older commercial aircraft, at a time in their life when an increase would have been expected.

How do you account for this? Is there any data that would help explain that?

Mr. BRODERICK. Well, I think that the *Los Angeles Times* article looked at a small segment of a long series of data. It turns out that while the statistics and numbers that they quote in that article are factually correct based on data that we in fact supplied to them, if you take a broader view of things, you will see a somewhat different picture.

For example, in the 1975, 1976, 1977 period, we had from 4,700 to 4,100 service difficulty reports for the six aircraft that they talked about. In 1985, we had 6,200 reports for those same six aircraft. Their data does not in fact do anything but look at a small segment of the data that is totally available.

There is no clear pattern of rising or declining in terms of service difficulty reports per aircraft. There is in fact a very weak relationship between time and the numbers, a declining relationship, but only for that 4 or 5-year period.

Senator KASSEBAUM. Thank you. There are 16 categories in major repairs which are required to be reported to the FAA as a service difficulty report. Other than these, each airline also has to report mechanical failure, "if in its opinion" they are dangerous. Do you see a need to increase the areas of mandatory reporting?

Mr. BRODERICK. I would like to have Owen Schroeder explain how the certification people use various sources of data from many different reporters when they analyze service difficulty problems, if I might.

Senator KASSEBAUM. Thank you.

Mr. Schroeder.

Mr. SCHROEDER. On the issue of the service difficulty reports, they are just one of the sources of our information. We get primarily the information that I use on a day to day basis in doing my job from the Boeing Company, from our DERs, which are our designated engineering representatives. I get another portion of the information directly from the FAA PMI system, which is our principal maintenance inspectors.

They report to me by phone call. If they note a discrepancy, for instance, at an airline, an airplane getting ready to leave, and there is something seriously wrong, they will call me directly. I view the SDRs as a backup system that does provide detailed data, but it is really primarily always a backup system to our other modes of finding out the information that I work with on a day to day basis.

Senator KASSEBAUM. Do we need more inspectors?

Mr. SCHROEDER. I am not familiar enough with that question to answer it, ma'am.

Mr. BRODERICK. Let me try to answer that, Madam Chairman. I think we do need more inspectors now. I think we need more inspectors, the Administrator does, and the Secretary thinks we need more inspectors. She has made it clear that she intends to increase the ranks of inspection and support people in the FAA over the three-year period of fiscal years 1986, 1987, and 1988 by at least 500 staff.

We are aggressively hiring now in accordance with the continuing resolution mandates and training our people, and we will in fact signficantly increase the number of inspectors on our rolls in the next few months.

Senator KASSEBAUM. That is really in some ways what I wanted to ask. Is it just numbers, or is it also the question of inspector training? I would think that you can not easily find good inspector and expect them to be doing the kind of thorough job that needs to be done in a

matter of a couple of months. I should think it would take a high degree of knowledge and training.

Let me ask, who does that training?

Mr. BRODERICK. Well, we have an extraordinarily high requirement for technical knowledge and training. The basic training is done by the people before they come to the FAA in the sense that they have to be appropriately educated and qualified to fulfill their responsibilities, but the FAA has a very large training program in our flight standards area.

We have just recently completed redoing the initial string courses of training for all of our inspectors, so for the first time now probably in the history of the FAA when an inspector, a newly hired inspector is brought in, they are not waiting 6, 12, or 18 months for training, but are programmed, hopefully within the first 30 days of their employment, to go to a series of usually four courses, one right after the other, down in Oklahoma City at our academy for a period of about 4 months, at which point they are accredited upon successful completion. This is a pass-fail course. Upon successful completion of those courses they are accredited with credentials and given inspector authorization.

That is only the beginning of their training. We are now formalizing an on-the-job-training program which really will last for the rest of their careers. In terms of becoming qualified to perform a number of very useful duties, that happens after four or five months through the training course at Oklahoma City.

In terms of being fully qualified to do a wide range of duties, not everything, of course—nobody does everything—but to do a wide range of duties and be a journeyman inspector, that probably takes somewhere between one and three years, depending on the experience and background of the individual.

Senator KASSEBAUM. Is it because of a shortage of inspectors that there is not the frequency, if that is the best word to use, of surveillance that Chairman Burnett was raising? He implied that he felt there should be far greater surveillance on the part of FAA.

Mr. BRODERICK. Madam Chairman, I think really it is a question of two things. Number one, it is numbers, but number two, it is commitment and priority. We have, in fact, just recently reprioritized the efforts of our entire field inspection work force. We have set forth program guidelines which are effective beginning this past October 1, that prescribe minimum requirements for inspection of all carriers throughout the country, and set priorities of accident investigation and surveillance first and certification of new entrants second.

It is that kind of prioritization of work and use of available resources in combination with the expansion of the available resources that will increase the actual number of surveillance inspections performed.

Senator KASSEBAUM. Thank you. Let me turn to Senator Exon at this point, and then I have some further questions.

Senator EXON. Madam Chairman, thank you very much.

Mr. Broderick, gentlemen, we are delighted to have you here this morning for this very important hearing. I want you to educate me a little bit on what role pilots play in safety. I do not fly an airplane, but I drive an automobile, and usually if there is something wrong with that automobile, I have some hint of it somewhere along the line. You know, the brakes are not operating exactly properly, and I put that off until I go in to get the car filled up with gasoline.

We are all procrastinators to one degree or another. Does the FAA take a close look at the reports of pilots that fly an airplane from Point A to Point B? I assume if the pilot notices that the response is not right on the thrust, or the landing gear does not go down exactly right, I assume the pilot in that case is required to make a report of that as part of a record before somebody else takes over and flies that aircraft.

Is there not quite an elaborate reporting procedure from pilots that the FAA has an opportunity to look at?

Mr. BRODERICK. Yes, sir. As a matter of fact, it is the primary source of what we call squawks from pilots and flight engineers. It varies in minor detail from carrier to carrier, but every carrier must have a comprehensive reporting system and recordkeeping system to not only permit the reporting of those squawks, but to require the reporting of them and appropriate attention given to them immediately so a decision can be made if the plane can be safely dispatched with that problem or if it must be fixed before dispatch.

Senator EXON. Let me ask you this question. Since you have now established that your agency does take a look at those reports, has there been any significant increase in difficulty with aircraft since deregulation? Is there any significant change in the number of complaints about pilots and crew chiefs about the operation of the airplane that they are flying?

Mr. BRODERICK. I do not think in absolute numbers, sir, but it would be misleading if I stopped there. What we have been concerned about and remain alert to and work with the industry on is the number of squawks or maintenance items that are reported by the pilots and deferred maintenance items.

What we do is very carefully track those, both on a company basis, on a fleet basis, for example, the 727s in this company and then the 737s in this company, to see if there is a fleet problem, and frankly, to see if people are deferring maintenance for reasons that are irrelevant to safety in each case. We do not want that to happen.

We have very precise rules about what may and may not be deferred, and the kinds of analysis that a company or a dispatch organization must go through before an airplane is released for service. I must say that in the vast majority of cases we have had very satisfactory performance on the part of airlines and crews.

Once in a while we find difficulties with airlines. It is not necessarily related to a large one or a small one or a profitable one or an unprofitable one. Once in a while those difficulties crop up, and when we find them we aggressively work with the companies to correct those problems. So it is deferred maintenance that we are more concerned about than absolute numbers.

Senator EXON. Are you having increasing, decreasing, or about the same number of complaints from pilots and crews with regard to equipment deficiencies? It seems to me that sometimes when labor discussions are about to take place we have more complaints about maintenance than we did previously. During strikes we seem to have—at least it is highlighted in the news media, that we have more complaints about the safety of those planes than we do at other times.

Is that just a mistaken assumption on my part, or does it seem to crop up at opportune times?

Mr. BRODERICK. I think your perception is accurate. Let me spend a second and tell you how we deal with that. We assume that any time there are financial difficulties, bankruptcy, a labor action, or a well publicized bad labor management relationship at a company, that we are going to have some difficulty of some kind, and we increase significantly as a matter of routine practice our surveillance on that carrier.

When I spoke earlier about the deferred maintenance items, I did not focus in on this particular kind of publicity that is associated sometimes with labor management disputes, because we treat those individually and separately, and frankly, spend an awful lot of time resolving each and every one of those complaints.

We cannot tell when a complaint is raised whether that complaint is real or artificial, so we assume it is real because we are a safety agency. We have to make that assumption, and we investigate it.

Senator EXON. Do you often times have situations where a crew just says I am not going to fly that airplane and walks off the airplane?

Mr. BRODERICK. I am sure it has happened a number of times.

Senator EXON. Has there been more of that in your opinion since deregulation?

Mr. BRODERICK. Not that I am aware of, but I must say it is anecdotal. I have never seen any statistics on that.

Senator EXON. I am not very much enthused about what I have heard of this bill where the Defense Department would take over safety inspections on the contract carriers that they hire. It seems to me that is in the prerogative of the FAA, and I would hope and expect that the same rules and regulations for safety would apply to a contract carrier even if that carrier is a low bidder with regard to the military.

You did not come right out and say it, but I took it from your response to an earlier question that you would generally share the view that I have just made in that regard, that that authority should remain with the FAA and not be separately designated to the Department of Defense?

Mr. BRODERICK. I certainly would share that view, sir, and I could refer you to the review of military charter operations in which we participated with the Department of Defense in reviewing, among other things, this very issue. One of the specific conclusions placed in that report that was just recently released was a reaffirmation of the primary role of the Secretary of Transportation and Federal Aviation Administrator in assuring the safety of airline operations.

Senator EXON. Immediately after that well-publicized and most disastrous crash at Newfoundland, there was a concern that the armed services were buying the low bidder award, and that that had some relation to the fact that the carrier was not doing proper maintenance.

Has that been substantiated? What has the FAA done to correct that, if anything, since that crash?

Mr. BRODERICK. Well, we have significantly stepped up the exchange of information between ourselves and the Department of Defense to provide them with data that we have on performance of the air carriers in terms of safety inspections, fines that are proposed, that kind of thing, but I think I would agree with what I take is the thrust of something you said, and that is that we have no evidence from the investigations that have been conducted to date on that accident that maintenance did or did not, either way, contribute to that accident.

I am not aware of anyone who has any solid evidence as to what the cause of that tragic accident actually was.

Senator EXON. I have no further questions. Thank you, Madam Chairman.

Senator KASSEBAUM. Thank you.

Senator Inouye.

Senator INOUYE. Thank you very much, Madam Chairman.

Mr. Broderick, I listened to the exchange of questions and answers between you and our gracious Chair, and I was impressed by two phrases, the need for more inspectors and the need for greater surveillance.

Is this a general indictment of airlines, to wit, personnel involved in operations and maintenance; they are either not sufficiently trained or competent, or that they are cutting corners?

Mr. BRODERICK. Senator, I would not say that at all. I would say that it is a reflection of our perception in the Federal Aviation Administration and the Department of Transportation.

Our perception of what the public demands and the degree of perfection that we are trying to achieve in airline safety. The industry is very large. It has grown considerably in the last 5 or 10 years. For various reasons of budget and economy the FAA inspector work force has not grown. We believe that it is necessary to increase the numbers of inspectors to provide for a reasonable, adequate level of oversight, to ensure that to the best of our ability all preventable accidents are in fact eliminated.

Senator INOUYE. What was the basis for the record-level fine recently imposed by the FAA against American Airlines? Was it the result of incompetence, or were they knowingly cutting corners?

Mr. BRODERICK. I think it was a lack of attention to the rate of expansion of operations, and overconfidence in the ability of their maintenance organization to track that.

As soon as we pointed out to American the discrepancy between the expansion of their operation and the non-expansion of the maintenance organization, I can tell you very honestly that the leaders of American Airlines, Mr. Crandall and his subordinates, very quickly addressed

those issues and corrected those problems months before anyone in the public even heard about it. Immediately upon the discrepancy being pointed out, they were working on a solution to the problem.

I think that is the kind of attitude that we have seen with virtually all the airlines whom we inspect and find difficulties with. It is a feeling of cooperation and a desire to, in fact, fulfill responsibilities rather than a desire to cut corners and pull the wool over our eyes.

Senator INOUYE. If that is the case, why were they required to pay such a high level of fines?

Mr. BRODERICK. I think that punitive action is called for—it's contemplated both in our authorities in the Federal Aviation Act and our Enforcement Handbook, and correction of a problem is not sufficient especially when you have a problem of the magnitude that we had with the carrier that carries the awesome responsibility of being one of the top one, two or three carriers in the world.

Senator INOUYE. Is there a correlation between age of an aircraft and the level of safety?

Mr. BRODERICK. Absolutely none that we know of, sir.

Senator INOUYE. So, even if the aircraft is old, it could be just as safe as a brand-new one?

Mr. BRODERICK. Well, in fact I'm quite certain from some studies I have seen of military aircraft, and I am sure—well, I'm not sure but I would suspect it might be the case—that aircraft, when they were first introduced, might have had a higher accident rate than later but normally that is due to a lack of knowledge of the handling characteristics of the airplane, especially in military aircraft.

In civilian aircraft, we have an extraordinarily low accident rate and trends like that would be very difficult, if not impossible, to find.

Senator INOUYE. Is fatigue life of an aircraft an important factor in safety?

Mr. BRODERICK. Fatigue is a very important factor in safety. I am not sure that we have a good handle on the fatigue life in the sense of the end of the useful life of any of our modern jet aircraft, or indeed of aircraft like a DC-3. It's really a question of economics, not safety, in the very old aircraft: do you want to pay for repairing it, or would you rather buy a new airplane.

Senator INOUYE. So, therefore, it is not necessary for you to require manufacturers to set a fatigue life of an aircraft?

Mr. BRODERICK. Not with the design concepts, as I indicated earlier, that we now employ and the analytical capabilities that we now have. For example, the supplemental structural inspection documents that have been developed for the Boeing 707 apply technology that wasn't available 30 years ago when that airplane was designed. But that analytical capability enables us to look retrospectively at the design and point out where, in the wisdom of 30 years of technology development, we would expect difficulties to crop up and we direct inspections to those particular areas.

So, in fact, even though the design didn't incorporate damage tolerance technology, our inspection program indirectly does.

Senator INOUYE. Well, I am much concerned about the safety of flying, because I believe I spend more time in aircraft than any other member of the U.S Senate. In the last 16 years I have kept a log and I believe I have averaged about twenty-three 24-hour days up in the air each year, with another 2½ days in airport lobbies.

So, we have jolly times.

Thank you very much, Madam Chairman.

Senator KASSEBAUM. Thank you. I would like to follow up on a question you asked, Senator Exon, regarding pilot reporting of safety problems, because there are those who feel this is quite a problem. I wonder if you are aware of reported incidents of carrier retaliation against employees who report safety problems to the FAA?

Does the FAA have present authority to sanction carriers who take such retaliatory action?

Mr. BRODERICK. We don't have that particular authority in the Federal Aviation Act. We do have a number of what I might call outreach efforts that are underway on a continuing basis to try to solicit these reports from pilots and maintenance people and flight attendants.

These include the NASA-operated, FAA-funded aviation safety reporting system, which is completely anonymous, and the FAA Safety Hotline which we have installed at FAA headquarters, both of which are quite effective in culling anonymous reports.

Senator KASSEBAUM. Do you feel that it would be necessary for you to have any legislative authority?

Mr. BRODERICK. I certainly haven't seen that need now, Senator.

Senator KASSEBAUM. I have several other questions I would like to pursue. The SSID programs relate primarily to fatigue cracking. Earlier, with Mr. Burnett, we talked about corrosion a bit.

The SSID programs don't relate directly to corrosion and those structural problems. How does the FAA intend to monitor this situation to make sure that corrosion in older aircraft will be properly addressed, and do you believe that maintenance standards for corrosion are adequate or should they be stricter and more extensive?

Mr. BRODERICK. To answer your second question first, I think that our maintenance standards are in fact adequate for corrosion. Those standards require detailed daily attention to corrosion from the time an airplane leaves the factory until the time it is taken out of your fleet.

Corrosion is different from fatigue damage in the following sense: If a structure has a given strength you might expect fatigue damage to occur sometime out in the future. Corrosion is a problem that you face every day in varying amounts in different parts of the aircraft.

The manufacturers, as Owen indicated, have sources of information from all over the world, from all the operators in every conceivable climatic environment. This data, coupled with the data that is provided by U.S. operators through our reporting system or directly to the manufacturer, provides an excellent way of attacking the corrosion control problem.

Let me point out that there are heavy economic incentives to control corrosion, because a lack of control of corrosion, way before it becomes a safety problem, makes your airplane worth an awful lot less than it would be if you maintained it properly.

I think our programs are adequate, and our safety record certainly demonstrates that.

Senator KASSEBAUM. To what extent, if any, are the areas of the aircraft which are accessible without removal of the skin, covered in the SSID program? Do you have any plans to ensure that these areas are adequately covered?

Let me say that I don't have any technical expertise. It would seem to be extremely difficult to remove a skin and try to have this be a continuing part of the monitoring process. I would like to have your thoughts on that.

Mr. BRODERICK. I think I will ask Mr. Schroeder to respond.

Mr. SCHROEDER. This is an item that has been addressed in the SSID program, the Supplemental Structural Inspection program. For instance, if you would take the wing, there are approximately 80-some areas on a 747 that have been designated as key areas, that if a crack were to occur in those areas it could, if not detected and repaired, eventually cause loss of a primary structural member.

To prevent that, the program has designated a need to go in there at some time within the next "D" check of an airplane, some certain period of time which is defined, and look at that area on the older airplanes in a given fleet. We have 140, 747's in the SSID program, and each of those aircraft, for each of those 80-some areas on the wing, will have that area looked at specifically.

If it requires draining the tank, putting a mask on and sending a man in there to peel away the sealant and look for the crack, they will do that. Our intent is that those areas, if they are critical, will be looked at.

We don't anticipate finding cracks there but we are going in to look to see if cracking is occurring, and these would be areas such as you mentioned that would be hidden in the normal maintenance type of look.

We don't intend to peel the skin back. We have techniques to look at these areas without that drastic a measure. We may need to peel the paint off, but that is another issue.

Senator KASSEBAUM. In light of the recent incident at La Guardia involving a combustion chamber failure on a Boeing 727 that had been maintained under the engine condition monitoring program, what plans do you have to review the adequacy of the ECM program?

Mr. BRODERICK. Perhaps I could ask Jay Pardee to answer that question.

Mr. PARDEE. Madam Chairman, the ECM programs that were in use at the time of that occurrence are programs of less stringency than will be mandated by the recently issued airworthiness directive. As Mr. Broderick described earlier, we have taken steps to apply significant increased controls of the more stringent data analyses and plotting for future use in engine monitoring programs than has been used in the past.

Again, that particular incident, we don't think is representative of the future of the programs that will be required under the new airworthiness directive.

Senator KASSEBAUM. So, you are saying you think the ECM is adequate in its design to monitor these particular situations?

Mr. PARDEE. I think I agree, Madam Chairman, but the Eastern occurrence by itself, I don't look at as a shortcoming in the system. Again, the revised engine condition monitoring program that will be required by the forthcoming AD, all carriers wishing to use that ECM program will be required to obtain approval from their local principal maintenance inspector and show to that inspector that they can in fact monitor a program and implement it as required by the current directive which, again, is more stringent than previous ECM program requirements.

Senator KASSEBAUM. How do you respond to Chairman Burnett's suggestion that a maintenance review board should be set up to monitor the JT8D and focus on the engine problems as the SSID has on structural areas?

Mr. BRODERICK. We in fact have just completed the inspection phase of a special focus series of inspections on 22 major engine maintenance facilities in the United States. The analysis of that information will provide us with a basis for response to that.

In effect, we have already done that by inspecting those organizations, both airlines and repair stations, working on an almost daily basis with the Board, the manufacturer and the airlines, to address these issues. So, I think that a final response would have to await the analysis of the data that we have, Madam Chairman.

Senator KASSEBAUM. One last question, and I think particularly having Mr. Pardee and Mr. Schroeder here is helpful. There has always been the question raised of whether the maintenance and inspector responsibilities perhaps cause some difficulty for those who over a period of time, work closely with those they are inspecting; that is do they develop a relationship with the manufacturers that is too close to lend the objectivity that is necessary?

Do you believe this is a problem? If it is, and obviously just by the requirements of the job, I could see where it could be, is there some means of addressing it, perhaps by rotation or some other means?

I would really welcome your thoughts on this.

Mr. BRODERICK. Let me try a stab at it. Mr. Pardee and Mr. Schroeder are both engineers as opposed to inspectors.

Senator KASSEBAUM. I realize that, but do you not oversee the requirements that have to be met by the inspectors? Is that your responsibility? As engineers, are you part of drawing up these requirements that need to be met?

Mr. BRODERICK. They provide the technical guidance material to the inspectors but do not directly have any oversight authority over the actual inspectors who are in another part of the FAA which also comes under me, the Flight Standards operation as opposed to the Certification operation. But that's a distinction without important difference, I think.

The answer to your question is, one that we have been trying to address over the last few months—we do intend, this year, to review the turnover and rotation actually experienced of inspectors in the flight standards area with an eye toward trying to develop a data base which we actually do not have right now.

That, combined with the advantages of the new relocation assistance program that is now available to people to make it a little bit more reasonable in terms of financial sacrifice to move within the FAA, I think probably is going to result in a reasonable addressing of this problem.

I am not sure what the answer is going to be, but we certainly share your concern in principle. You know, there should be a gut feeling that at some length of time you have been there too long. On the other hand, we have to remember that this is a very complex, technological business and you can't just go from one organization to another and be productive in a short period of time.

So, like everything else, it seems there is a balance that must be struck.

Senator KASSEBAUM. Thank you. —

Did you have anything else, Senator Exon?

Senator EXON. I have one last question.

Mr. Broderick, what type of aircraft was it that crashed in Japan, the JAL plane that went into a mountain because the tail section failed?

Mr. BRODERICK. It was a special 747 model called the SR.

Senator EXON. SR, it was a 747?

Mr. BRODERICK. Yes, sir.

Senator EXON. I noticed the other day that—I guess it was your agency that directed a change, putting on a different trap door of some kind under that airplane that failed under pressure, as I understand it?

Mr. BRODERICK. Yes, sir.

Senator EXON. Under pressure meant, when they got up to 30,000 or 35,000 feet where they needed pressure, and that door failed—that 747 has been around for a long time and the SR version of it, I believe also has been, has it not? How many years?

Mr. BRODERICK. The SR, I believe, was certified in the mid-70s. The 747 has been around since the early 1970s, and those airplanes are in fact close to, if not the high-time airplanes in the Boeing fleet.

They have very high utilization. They are used in a shuttle operation similar to the New York-Washington shuttle.

Senator EXON. Now, as I understand it, everyone has agreed that the suggested changes had to be made with that aircraft. Were there previous indications of this type of potential failure that caused a crash of that JAL plane?

Mr. BRODERICK. Sir, we do not have a full report and determination of probable cause on that accident. However, the failure that appears to have occurred is the failure of a repair, not the original structure of the airplane.

So, while one might associate the failure of that repair with fatigue, it's a special case. It was in a very unusual situation, sort of a one-of-a-kind situation.

We have been aware—and the bulkhead is the subject of intensive testing all the time. We will use the information we have gleaned both from this accident and the extraordinarily detailed inspections that the Japanese have conducted since then of their SR fleet, to analyze and determine whether or not any additional steps are necessary to be taken.

Senator EXON. Well, I guess my question comes down to this. Let me ask you the question again. I'm not sure it was really answered.

Were there other previous incidents like the crash of that JAL SR-747 that may not have received the attention that they should have?

Mr. BRODERICK. Not with the 747, sir. There have been very few incidents, even like that, and I am unaware of anything that one could say should have received more attention.

Senator EXON. And if I understand it as a layman, what you are saying is that that was not basic design structure, that was changes that occurred in the maintenance process of that particular aircraft, that likely caused the accident?

Mr. BRODERICK. It was a field repair that was done to that part of the airplane after it was in a minor accident.

Senator EXON. After it was in a minor accident?

Mr. BRODERICK. That's correct. That repair failed.

Senator EXON. Thank you. Thank you, Madam Chairman.

Senator KASSEBAUM. Thank you, Mr. Broderick, Mr. Pardee and Mr. Schroeder. We appreciate your testimony.

[The statement follows:]

STATEMENT OF ANTHONY J. BRODERICK, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS, FAA

Madam Chairman and Members of the Subcommittee: I welcome the opportunity to appear before the Subcommittee today to discuss both the FAA's process for certificating charter air carrier operators and the subject of aging aircraft in the air carrier fleet. These are important issues which warrant the continued interest of all within the aviation community.

The subject of aging aircraft in the Nation's air carrier fleet is one we have been concerned with and have aggressively been addressing for some time now in cooperation with both manufacturers and the airlines. It is readily apparent that, as the age of individual aircraft used in the fleet continues to increase, the opportunities for corrosion or fatigue of critical components of those aircraft likewise increase. Therefore, the challenge which has faced us, along with manufacturers and operators, has been to develop design standards which reduce the likelihood of catastrophic failure, prescribe inspection intervals which will enable cracks or corrosion to be detected prior to the onset of failures of critical components, and monitor service history of aircraft not only as a means of improving our design standards and refining inspection intervals but to permit the timely correction of potential problems by the issuance of regulatory airworthiness directives (AD's). We have continued to improve upon our ability to achieve these important objectives.

In the early 1950's, the standards relied upon careful detail design to prevent the failure of key aircraft components by fatigue. Under this approach, we depended upon a maintenance program developed on the basis of previous transport service experience. "Hard time" inspection programs were used.

Before the advent of the jet age in the late 1950's, the FAA developed standards which permitted either a "safe-life" or a "fail safe" approach to design for fatigue. Under the safe-life approach, there was a required scheduled replacement of a part in accordance with the expected life of the part. The aircraft was simply retired from service when it became impractical to replace a part such as a wing or fuselage. Starting with the B-707, the fail safe approach was applied in the design of all U.S. commercial jets. Parts were constructed with a built-in redundancy under the premise that the aircraft could operate safety with an undetected flaw until the next scheduled inspection could correct it. Under this philosphy, aircraft are designed so that the rate of crack propagration will not reach a critical stage prior to the next scheduled inspection or maintenance.

Manufacturers were called upon to recommend maintenance/inspection schedules, based on test data, at the time a new aircraft was introduced into service. Changes to the maintenance/inspection schedules could be approved for individual airlines if they could demonstrate that the changes to the maintenance program would also provide a comparable level of safety. In that respect, I would note that the fatigue life expectancy of a structure can only be finally determined after exposure to a variety of environmental conditions over many years of operation, so service history is a critical aspect of validating assumptions made during the design process and in assuring the continued airworthiness of an aircraft.

In 1978, the FAA introduced a newer design concept for newly certificated aircraft which is called "damage tolerance." A damage tolerant structure is one which has been designed to tolerate damage due to fatigue, corrosion, or accidental damage and continue to carry expected operational loads until detected either by the problem becoming evident or during a scheduled inspection. Scheduled inspections of such components are based on the fracture mechanics characteristics of the part, and are designed to detect any crack before it reaches unsafe proportions. In other words, under the damage tolerance approach, we assume that damage will occur to a part from any of a number of possible conditions, including poor maintenance practices. That part must then be designed to safely accommodate that damage, until it can be corrected. The safe life approach could continue to be used for aircraft components on newly certificated aircraft to the extent that damage tolerance was not appropriate. One example where the safe life approach is used (i.e., a specific life use is placed on the component) is for landing gear.

We believe damage tolerance will provide improvements in aircraft design for future aircraft, but it does not apply directly to the vast majority of the aircraft in the current air carrier fleet because they were certificated prior to our adoption of the damage tolerance rule in 1978. Therefore, to address on a more current basis the need to assure that fatigue and corrosion were detected on aircraft in the fleet, the FAA issued guidance information to industry which outlines methods (including fracture mechanics assessment) to assure safety of older airplanes through additional structural inspections.

The number and extent of these additional structural inspections are based on an engineering analysis that assumes the existence of a crack at all critical locations and determines its growth rate and the point at which it would become unsafe. This approach, which we finalized in concert with industry in 1981, is called the "Supplemental Structural Inspection Documents" (SSID) program. Under SSID, manufacturers are asked to identify all structural components whose failure could affect the safety of the aircraft, and to establish a special inspection program for these components. To date, SSID's have been developed for the B-707, 727, 737, and 747. The FAA has taken regulatory action to require the airlines to adhere to the schedules called for in these SSID's. We expect to see SSID's developed for the DC-9-10, 9-30, 9-40, 9-50, tne DC-10, and the L1011 within approximately the next two years, and would anticipate appropriate regulatory action to require compliance with their terms as well. The DC-8 and BAC 1-11 have SSID's, which have not yet been established as mandatory by the FAA.

In terms of the issue of aging aircraft, I believe it is important to note that we are not experiencing a degradation of safety in commercial aviation, and that there is not cause for alarm. Clearly, the situation is one that merits attention and continued action on our parts. Significantly, we have established an overall system in which all parties have an important role, and in which all parties must fulfill their functions responsibly and with the safety of the travelling public foremost in their minds. The FAA, in addition to prescribing the appropriate regulatory framework and developing pertinent guidance material for use by industry, will continue to monitor the way in which all elements of this cooperative system are meeting their obligations.

In terms of the certification of new charter air carriers, we go through a detailed process of assuring ourselves that a proposed applicant meets the stringent requirements of Part 121 of the Federal Aviation Regulations, which govern the safety certification of new air carriers. I would like to take a few moments now to describe this process to you.

An applicant for an air carrier operating certificate applies for safety certification through our flight standards field offices. Typically, informal meetings are held to inform the applicant of the requirements and procedures for certification and for the FAA to make initial assessments of the applicant's potential capabilities. The action which more formally begins the process is a "Pre-Application Statement of Intent" to start operations, which the applicant would provide to the field office. This material outlines the applicant's proposed scope and type of operations, type of equipment, areas of operations, and airports to be used, etc.

The next step would be for the carrier to flesh out the details of its proposed enterprise by submitting a formal application in letter form. Accompanying the formal application, or to be followed shortly thereafter, would be the carrier's proposed general operations, maintenance and training manuals along with checklists, Approved Airplane Flight Manuals, Minimum Equipment List, and other documents needed to evaluate its readiness to conduct air transportation in compliance with the regulations and safe operating practices. We would be looking to evaluate such factors as whether the carrier had the capability to maintain aircraft in an airworthy condition, properly train crewmembers, dispatchers and maintenance personnel, or safely turn around aircraft and crews from one flight to the next flight.

As part of the formal application, the new carrier would be required to submit an initial compliance statement, which lists all regulations appropiate to its proposed operations and how it intends to meet those regulations. Typically, the compliance statement would cite appropriate provisons in its required manuals which spell out in detail how these functions will be carried out. FAA, of course, reviews this document to make sure that all pertinent regulations have been listed, and that the proposed means of compliance are adequate.

As these "paper" reviews are being conducted, we move into the next phase of our examination of the carrier, that is field inspections. FAA inspectors monitor the performance of such tasks as the training and checking of personnel and the inspection of proposed maintenance facilities. We examine the aircraft to be used to see if they meet certification and operational requirements. As this process evolves, we look at the proposed management personnel to see if they have the knowledge and experience needed to operate an airline. We also look at the compliance history of the people who will be involved in the management of the company.

At some point, usually in the later phases of the process, the carrier applicant would be required to submit to the FAA a plan for "proving flights" which, as the name suggests, are flights in which the applicant proves to FAA's satisfaction that it has the capability to actually run an airline in compliance with the regulations and consistent with safe operating practices. While a carrier may receive credit for

ferry flights and FAA-observed training flights, it must also make plans to conduct flights which would be representative of their proposed operation—a dress rehearsal, so to speak. A carrier may request a reduction in the hours of proving flights required, based on the capabilities and past experience of its personnel. Despite any reduction which may be granted when FAA accepts the plan, the key factor is that the carrier must prove to the FAA's satisfaction, through the proving flights, that it can safely run an airline. Thus, if the FAA discovers any deficiencies in the carrier applicant's procedures, that applicant will have to correct the problems and demonstrate that it has done so, even if this results in having to fly more hours of proving flights than called for in the plan. Likewise, if a carrier demonstrates its capabilities to FAA's satisfaction prior to the completion of the number of hours of proving flights called for by the plan, no further flights would be required. In short, the carrier applicant must demonstrate its ability to comply with the applicable regulations and the procedures and programs contained in its manuals irrespective of the number of hours of proving flights in its plan.

Once the plan for proving flights is accepted, FAA begins more intensive surveillance of the applicant. An emergency evacuation demonstration is conducted, which tests the emergency equipment as well as the applicant's ability to maintain such equipment. The evacuation demonstration also verifies in a practical manner the quality of training given to the cockpit and cabin crewmembers on the use of the emergency equipment and the procedures to be used during an emergency evacuation. During ferry or training flights, the applicant's maintenance programs, procedures and capabilities are examined. As previously mentioned, the carrier applicant would be required to fly into a number of the airports that are representative of those it proposes to serve. During these flights, FAA inspectors examine the competence of flight crews, flight dispatchers, flight attendants, and ground personnel; the adequacy of maintenance programs and fueling procedures; and management's capabilities in the exercise of operational control. We also pose hypothetical problems for the crews and the company's operational control systems to see how they would react in unusual situations such as weather diversions and/or equipment failures. In essence, the proving flights are used by the FAA to verify that the carrier applicant can actually conduct its operations in accordance with the proposed methods and conditions set forth in its compliance statement.

After each proving flight, an FAA inspector briefs the applicant's management on any deficiencies detected during the flight or during ground operations, and the applicant must take action to correct these deficiencies. If they are major, the applicant must demonstrate the effectiveness of the corrective action by conducting additional flights. Once the FAA is satisfied that the carrier applicant's programs and systems adequately provide for compliance with the regulations and safe operating practices, the proving flights are terminated. Only after a successful demonstration by way of proving flights is an Air Carrier Operating Certificate granted to the carrier, along with operations specifications, which detail the conditions under which the carrier may operate.

The flight standards field office is required to prepare a certification report and forward it to the region, which in turn forwards a copy to headquarters. The field office also notifies OST that we have granted the certificate. Once the carrier has also obtained the necessary approval of economic authority from OST, the carrier may begin to operate.

As you can see, the certification process for any carrier is quite exhaustive. And our involvement with that carrier does not, of course, end there. We continue to oversee that carrier's operations in accordance with our ongoing surveillance program in order to assure the continued compliance with our regulatory requirements.

That completes my prepared statement, Madam Chairman. I would be pleased to respond to questions you may have at this time.

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### Questions of Senator Exon and the Answers

*Question 1.* According to testimony presented by NTSB Chairman Burnett, the FAA has no regulations in place that directly address the age of aircraft. Neither is there a requirement that a manufacturer must determine or estimate fatigue life or the safe life of an airplane. Is that correct? Why is that the case?

Answer. Several regulations are in place which address the effects of age on an aircraft. FAR 25.603 requires the manufacturer to establish the durability of critical parts based on tests or service experience. FAR 25.609 requires structures to be protected from deterioration in service from weathering, corrosion, and other causes.

FAR 25.571 requires an evaluation of an aircraft to assure that failure due to fatigue, corrosion or accidental damage will be avoided throughout the operational life of the airplane.

Portions of an airplane, such as the landing gear, are typically designed to the safe-life requirement of FAR 25.571(c), and mandatory retirement times based on fatigue tests are specified. Structural parts designed to FAR 25.571(b) do not have mandatory retirement times, since, if these parts are properly maintained and inspected in accordance with manufacturer recommended FAA-approved procedures, their structural integrity will not deteriorate to an unsafe level.

*Question 2.* Several months ago, fuselage frame cracks of up to ¾ of an inch were discovered in the nose of a number of Boeing 747 aircraft. Yet, the FAA-approved plan for inspecting the aircraft, the Supplemental Structural Inspection Program, failed to identify these cracks. Does this indicate that this program is lacking in its effectiveness for identifying maintenance trouble spots?

Answer. The Supplemental Structural Inspection Document (SSID) Program is only a part of the overall FAA-approved airline maintenance program. The SSID inspection requirements were designed to supplement the FAA-approved airline maintenance program. The airworthiness directive which makes the SSID mandatory requires the operators to incorporate inspections of critical structure into their maintenance programs if these inspections are not already in place.

As a result of the operators' ongoing, FAA-approved inspection programs, the FAA has been aware that this area in the Boeing 747 was susceptible to premature cracking. The cracking of the fuselage frames was found as a result of specific inspections of the frame structure in the nose of the airplane. The cracking was found prior to any airplane's being unable to meet regulatory flight load requirements, and suggests to us that the inspection programs are working.

*Question 3.* Last week, the National Transportation Safety Board renewed recommendations that the adequacy of the Engine Condition Monitoring (ECM) program, which allows each airline to establish procedures for ensuring maintenance and inspections of their aircraft engines, be reviewed. This is in light of a number of engine failures that went undetected by the carriers' ECM programs. What has been the FAA's reaction to this safety recommendation?

Answer. The FAA has reviewed the Engine Condition Monitoring Program (ECM), and we have determined that ECM programs are effective in detecting turbine-engine power deterioration. The ECM program requires the operator to demonstrate its ability to collect data of the kind specified; prepare meaningful reports from these data; assess the data; and take appropriate action. It is only when the data is not properly assessed and appropriate action not taken in a timely manner that engine power deterioration could go undetected and engine failures could occur. To preclude this from happening, FAA issued an Airworthiness Directive Amendment 39-5277 on March 27, 1986, establishing standards for the JT8D ECM program. This airworthiness directive becomes effective 5/19/86. Operators of Pratt and Whitney JT8D engines wishing to take credit for ECM programs will be required to demonstrate to their principal maintenance inspector that their ECM program is effective.

*Question 4.* We continually hear that the airlines are doing an adequate job of maintaining their fleets. Yet, it has been reported by the Los Angles Times that Department of Labor statistics show 4,300 fewer airline mechanics today than in 1980. How can this reduction justify the claim?

Answer. The FAA does not consider a reduction in the number of mechanics employed by an airline as an indicator of its ability to properly maintain its fleet for a variety of reasons. For example:

Some operators are contracting maintenance to repair stations. The mechanics in repair stations are not included in the airline count.

Improved aircraft and system designs have reduced the need for nonroutine maintenance.

Modifications of older aircraft to improved aircraft designs or systems have also lessened the need for mechanics.

Finally, new aircraft, such as the Boeing 757 and 767, have resulted in considerable improvements in maintenance performance efficiency.

*Question 5.* Since the Secretary announced her intention last September to hire additional maintenance and safety inspectors for the FAA, how many have actually been added to the workforce?

Answer. The FAA received budget authority for the additional positions in the FY 1986 Continuing Resolution on December 19, 1985. Recruitment was initiated and the first of these additional inspectors started coming onboard in March. A total of 73 inspectors were hired in March.

*Question 6.* In recent months, as the FAA "swat teams" of inspectors have reviewed individual airline operations, several thousand violations have been identified, resulting in the imposition of multi-million dollar fines. In the case of one of our witnesses today, American Airlines, those fines totalled $1.5 million. For another airline, Eastern Airlines, they totalled $9.5 million. Why haven't FAA inspectors identified these types of violations during their normal surveillance of air carrier operations? Doesn't this seem to indicate the current system of self-compliance with respect to maintenance simply no longer works?

Answer. During original certification, an airline is required to have a satisfactory maintenance program and an infrastructure to manage the program. Periodically, the FAA conducts inspections to evaluate program effectiveness and to verify that the airline is in compliance with its program and the Federal Aviation Regulations (FAR). An FAA field inspector, during normal surveillance of an air carrier, determines the overall health of that air carrier by a systematic inspection of that carrier. When, during normal surveillance, the inspector finds that problems exist, the inspector may call for a special indepth inspection of the airline by a team of inspectors. These extensive indepth inspections of suspected or known problem areas usually uncover more violations than are found during the normal surveillance activities.

In the recent past, the airline industry has increased significantly without a corresponding increase in the inspector workforce. The FAA is in the process of hiring more inspectors. Additionally, the FAA has initiated an ongoing National Inspection Program to periodically review air carrier performance indepth. National program guidelines have also been established that systematically cover each part of the air carrier's maintenance system on an ongoing basis.

Each air carrier has within its maintenance program a system for self audit. The system, known as the continuing analysis and surveillance system, evaluates the performance and effectiveness of the airline inspection program, other maintenance, preventive maintenance and alterations, and the correction of deficiencies in these programs. The FAA has evaluated self audit programs and found them to be effective and working well when properly applied by the air carrier. In instances where the self audit has not been properly applied, enforcement actions have been taken.

Senator KASSEBAUM. Let me now ask the panel if they wouldn't mind waiting for a moment because Mr. Baker of American Airlines has to catch a plane at 1:00, so Mr. Baker will be our next witness.

It is a pleasure to welcome you. Let me say that I certainly appreciate very much American Airlines being willing to testify today, and we will value hearing your comments. Mr. Robert Baker.

## STATEMENT OF ROBERT W. BAKER, SENIOR VICE PRESIDENT, OPERATIONS, AMERICAN AIRLINES, INC.

Mr. BAKER. Thank you, Madam Chairman and members of the subcommittee. Thank you for inviting American to represent the air carrier industry in this important subject. I have submitted a full statement for the record, so I will attempt to summarize the highlights of that statement.

A number of factors other than chronological age affect the operational and economic life of a modern jet aircraft. These include flying time, total landings and take-offs, or what we call cycles, operating environments, the mission requirements of the airplane, direct operating cost, customer appeal and acceptance, the state of the art of technological advances, and of course, noise constraints.

The chronological age of an airplane is a determinant of operational and economic life only to the extent that it affects one or more of the factors set forth above. As a case in point, Air Force 2, which is still

operated by our government, was placed in service some 23 and a half years ago.

The maintenance requirements of any given airplane are a product of both flight hours and landings and takeoffs, or flight cycles. As a result, the maintenance requirements of airplanes of the same chronological age may be significantly different because of variations in the number of flight hours or takeoffs and landings.

Airline maintenance programs are designed to ensure inspection, repair or replacement of aircraft components as they reach specified levels of flight hours and takeoff and landing cycles. These maintenance programs are initially based on tests and recommendations of the manufacturers, but are revised thereafter based on operator and industry experience.

All maintenance programs and all changes to those programs are supervised and approved by the FAA. The maintenance programs applied to any given aircraft really fall into three basic categories: systems and components, cabin interiors, and aircraft structure.

The first category, systems and components, include the engines and landing gear. As these and other major systems and components accumulate flight hours and cycles, experience and manufacturers' data are used to determine the intervals at which they are to be inspected or replaced.

Continuing replacement ensures continuing safe and reliable operation. Thus, the major systems and components on a mature aircraft fleet may not be chronologically older than those on a much younger fleet.

The second area addressed by maintenance programs involves cabin interiors. Maintenance of aircraft interiors are based on factors other than accumulated flight hours and cycles, and these are basically the desires of the carrier and the marketing style with which they wish to conduct their operations.

The third category of maintenance programs, one that is directly affected by flight hours and cycles, involves the aircraft structure. Commercial jet aircraft are subjected to comprehensive fatigue, static and flight testing before ever entering commercial service.

This testing, which is performed in conjunction with the certification of the aircraft type by the FAA, is the basis for the development of an initial structural maintenance program. Thereafter, manufacturers and airlines share their test data and operating experiences to develop more refined inspection procedures and maintenance intervals that are incorporated in revised structural maintenance programs.

These programs are likewise reviewed and approved by the FAA. The significance of higher levels of hours and cycles on a particular aircraft fleet are evaluated on an ongoing basis by means of an industry inspection program that extends to all significant structural elements of an aircraft.

In our view, higher levels of flight hours and cycles are not a limitation on the continued safe operation of an aircraft, so long as the industry in cooperation with the FAA continues to develop and implement aggressive inspection programs to assure early detection of

problems associated with the more extended useful lives now becoming common among the carriers.

As a case in point, the early group of 81 Boeing 727 aircraft operated by American Airlines has been in service between 17 and 22 years. The high time aircraft in this fleet has 51,200 flight hours and 43,400 cycles.

Over the years American has accomplished three distinct major structural modification programs on this fleet of aircraft. Late in 1985 American launched yet a fourth life extension program for these aircraft involving still further structural modifications.

Our 1973 through 1985 structural life extension programs have cost approximately $100 million, and we estimate that this most recent program, begun this year, will cost as much as $13 million and a half.

As a consequence of these improvements our direct aircraft maintenance costs on the 727 aircraft fleet have increased over the years, reflecting the cost of this restoration and rejuvenation process that has taken place. Specifically, American has increased its direct airframe maintenance costs on the 727 fleet by some 55 percent between 1980 and 1985.

Experience has shown that each airline can benefit from the intelligence provided by other operators. For this reason we believe that all airlines operating a specific type of aircraft should participate in regular, periodic review forums conducted by the aircraft manufacturer to examine and exchange information and technical analysis relative to the aircraft in question.

These meetings would enhance the quality of the data available and enable the industry to devise ever better maintenance and modification programs in the future.

In summary, it is our view that neither chronological age nor cumulative flight hours and cycles limit the continued safe operation of an aircraft. The progressive incorporation of structural modifications together with continuing inspection and refurbishment programs serves to extend an airplane's useful life until its either increased operating costs or environmental conditions dictate its retirement from service.

The Douglas DC-3 which was first flown in commercial service 50 years ago by American Airlines is perhaps the best example of a chronologically old type of aircraft that is still capable of providing safe air transportation as a result of airline maintenance programs.

Thank you very much.

Senator KASSEBAUM. Thank you, Mr. Baker. Some have suggested that the hub system of scheduling has made it that much more difficult for airlines to perform adequate inspection and maintenance, since the aircraft spends so little time at that particular hub. Has American found this to be a problem?

Mr. BAKER. It certainly has caused us to change the way in which we have aligned our maintenance resources, both people and spare parts and testing equipment. Airplanes, as constrasted to the years prior to the hub and spoke, are now spending their night-time hours out at the ends of the spokes, if you will, and therefore we have had to somewhat deconcentrate our maintenance resources and open more maintenance

cities out-board of the hubs to deal with the airplanes when they are on the ground at night.

So, it's caused a necessity for a great deal more planning and resource reallocation within the company.

Senator KASSEBAUM. Do you contract out more for that maintenance work?

Mr. BAKER. We contract out as a matter of policy and philosophy at American, only for what we call on-call maintenance. Those are situations where an aircraft is in a city where we do not have full-time American Airlines mechanics and the aircraft has difficulty.

We have a contractor in each city, usually another airline or a fixed base operator, to deal only with that specific problem. We do not contract out any inspection or overhaul work on our fleet.

Senator KASSEBAUM. There has been a lot of discussion recently about the reduction in the amount of spending by airlines for structural inspection and repair, yet the methods of finding structural cracks are limited and are certainly very labor-intensive. How do you account for this?

Mr. BAKER. The most recent piece of data I have seen that would seem to indicate that the expenditures on the part of the carriers have decreased relative to the age and use of the airplanes goes to an article of recent weeks in the *Los Angeles Times.*

Unfortunately, in the article they didn't adequately disclose exactly how they had used the Form 41 data from which to draw their statistics and make conclusions. It is very difficult, without knowing the specifics of a given carrier, to make those calculations.

The Form 41 data supplied by the industry to the CAB basically falls into three categories: airframes, engines, and other. Within airframes, a component of total airframe cost is structural inspection and repair, but also within that general category of airframes include control services, hydraulics and electrics, interiors, APU's, landing gears.

I don't quite understand or know exactly how the *Los Angeles Times* extracted the only structures piece from those industry data. At American our structural costs on our older fleets, and our older fleet is the 727, have gone up rather significantly over the last several years and we anticipate that they will continue to escalate as we conduct the structural inspection and modification programs.

We don't think that's unusual as the airplane gets older. Roughly 16 percent of our costs on the 727 fleet in total, our direct maintenance costs, are for structural inspections and repairs only.

Senator KASSEBAUM. You mentioned extension of time in your testimony. I wondered on what basis do you request an extension of time, and of particular concern to me would be the extension of C and D checks which are designed, among other things, to inspect for fatigue, cracking.

What do you take into account when you ask for an extension of time?

Mr. BAKER. Extensions are asked for only when the specific inspection evidence indicates that that particular inspection has shown negative findings or unimportant findings and therefore it is justified to examine both our experience, the rest of the industry, and in concert with the manufacturer to look at an extension for a particular and finite inspection of part of an airplane.

Our particular trend at American is to reduce the intervals of inspections on many areas of the airplane to produce a more reliable airplane for our field operations.

Senator KASSEBAUM. But you don't have, necessarily, any criteria that you use?

Mr. BAKER. It is basically the findings of inspections, the reliability and performance of the airplane while it's on the line, banked up against the other operators' experience in that same area of the aircraft.

Senator KASSEBAUM. Is there coordination with other operators?

Mr. BAKER. Very much so, particularly through the manufacturer and through the FAA, so we can determine if our findings are totally consistent or inconsistent with the rest of the industry and, of course, any extension must be reviewed and approved by the FAA and they have at their calling the data of the other operators.

We think that the real key to older airplanes is a combination of gathering absolutely as much data as we can possibly find from all operators and through a formal process with the manufacturers, assimilate this data so that the best minds in the manufacturing sector, the FAA and the operators, can make decisions about what ought to be inspected and how often, and then the type of repair once you've found a particular problem.

Senator KASSEBAUM. Does American maintain all of their aircraft under the SSID program, or only enumerated candidate airplanes, and do you believe that, for example, all 727's should be subject to the SSID inspection?

Mr. BAKER. We maintain our 727 fleet under that program. We are expecting that program for the DC-10, but we are involved in an ongoing structural inspection review and modification program even before that becomes a formal document, and we believe and intend that all of our fleets will be maintained under that program. We find it very beneficial and useful.

Senator KASSEBAUM. You mentioned the review forum as a way, I assume, that would help enforce maintenance standards and be an improvement, perhaps, on the procedure. Is that one suggestion that you are making? Although, I would guess, in the light of your extension remarks on inspection, that this is already somewhat of a review process that is ongoing.

Mr. BAKER. It is. We would like to see even greater depth and breadth of information that is transferred between operators and manufacturers and the FAA, and we would like an opportunity under a forum with the manufacturer to review with the other operators exactly what they are seeing, face-to-face, in their particular airplanes that we also operate, discuss the most prudent way to establish inspections, and

repair techniques and see if we can't just do a better job because we believe the data in this area is all-powerful in making the right decisions.

Senator KASSEBAUM. Has there been any effort on the part of the carriers to put something like this together?

Mr. BAKER. The manufacturers do conduct at least annually and often semiannually fleet group meetings of all the operators on a permissive basis, that is, you are invited as an operator of a particular aircraft to come to the meeting and review the aircraft's performance and system problems. And so, we get a little bit of that going. It has been going for several years.

We would like to see all operators present at the table when we discuss a particular airplane, because they may have experiences unique to themselves and their operating environment into which we are about to begin operating airplanes, or which we, because of the chronological age of our particular fleet, may be following their experience by a couple of years and we should see what they are seeing a couple of years down the road.

We would like to see all operators participate in this data collection and transfer and discussion process to maximize our intelligence about these airplanes.

Senator KASSEBAUM. Thank you very much, Mr. Baker. We certainly appreciate your testimony this morning.

Mr. BAKER. Thank you.

[The statement follows:]

STATEMENT OF ROBERT W. BAKER, SENIOR VICE PRESIDENT—OPERATIONS, AMERICAN AIRLINES, INC.

MAINTENANCE OF MATURE AIRCRAFT FLEETS

A number of factors other than chronological age affect the operational and economic life of a modern jet aircraft. These include:

—Total flying time
—Total landings/take-offs (flight cycles)
—Operating environment
—Mission Requirements
—Direct operating costs
  —Fuel
  —Crew Costs
  —System Reliability
  —Maintenance material costs
—Customer appeal and acceptance
—State of the art technological advances
—Noise constraints.

The chronological age of an airplane is a determinant of operational and economic life only to the extent that it affects one or more of the factors set forth above. As a case in point, Air Force 2, which is still operated by our government, was placed in service 23.5 years ago.

The airlines are, of course, responsible for maintaining their aircraft in a manner that will ensure continued safe, reliable operation. This is done by means of maintenance programs jointly developed by airlines and manufacturers and approved by the FAA. These programs are tailored specifically for each aircraft type, and for each operator's mission for the aircraft.

The maintenance requirements of any given airplane are a product of both flight hours and landings/takeoffs (flight cycles). An aircraft operated in long-haul service may accumulate 10 to 12 flight hours per day, with only 1 to 2 takeoff and landing cycles. On the other hand, an aircraft of the same type operated in shorter haul service may accumulate only 7 to 10 flight hours per day with 6 to 8 takeoff and landing cycles. As a result, the maintenance requirements of airplanes of the same chronological age may be significantly different because of variations in the number of flight hours or take off and landing cycles.

Airline maintenance programs are designed to ensure inspection, repair or replacement of aircraft components as they reach specified levels of flight hours and takeoff and landing cycles. These maintenance programs are initially based on tests and recommendations of the manufacturers, but are revised thereafter based on operator and industry experience. For example, such experience may dictate changes in the aircraft inspection intervals. Experience may also give rise to revised maintenance procedures to correct deficiencies, make improvements, and repair or replace the components, systems and structure of the aircraft on a timely basis. All maintenance programs and all changes to those programs are supervised and approved by the FAA.

Factors other than flight hours and cycles, such as the environment in which an aircraft is operated, may also give rise to special maintenance requirements. American Airlines' increased operations in the Caribbean, for example, has made corrosion detection, correction, and prevention an important part of its aircraft maintenance programs.

The maintenance programs applied to any given aircraft fall into three categories: (1) systems and components, (2) cabin interiors, and (3) aircraft structure.

The first category, systems and components, includes the engines and landing gear. As these and other major systems and components accumulate flight hours and cycles, experience and manufacturer's data are used to determine the intervals at which they are to be inspected or replaced. Continuing replacement ensures continuing safe and reliable operation. Thus, the major systems and components on a mature aircraft fleet may not be chronologically "older" than those on a much younger fleet.

The second area addressed by maintenance programs involves cabin interiors. Maintenance of aircraft interiors is based on factors other than accumulated flight hours and cycles. These include the number of passengers that occupy the seats each day, the number and times that meals are served from the galleys, and other factors that give rise to wear and tear of the bulkheads, carpet, upholstery, lavatory components, etc. Cabin interior maintenance programs restore the appearance and functionality in accordance with both safety and cosmetic standards.

The third category of maintenance programs, one that is directly affected by flight hours and cycles, involves the basic aircraft structure. Commercial jet aircraft are subjected to comprehensive fatigue, static, and flight testing before entering commercial service. This testing, which is performed in conjunction with the certification of the aircraft type by the FAA, is the basis for the development of an initial structural maintenance program. Thereafter manufacturers and airlines share their test data and operating experience to develop more refined inspection procedures and maintenance intervals that are incorporated in revised structural maintenance programs. These programs are reviewed and approved by the FAA.

The significance of higher levels of hours and cycles on a particular aircraft fleet are evaluated on an on-going basis by means of an industry inspection program that extends to all significant structural elements of an aircraft. This program, developed by means of cooperation among operators and manufacturers, makes available to every participant the cumulative results of the industry's inspection and testing programs. This data is also used by each aircraft manufacturer to prescribe programs of additional inspections which ensure prompt detection and correction of any new problems.

In our view, higher levels of flight hours and cycles are not a limitation on the continued safe operation of an aircraft, so long as the industry, in cooperation with the FAA, continues to develop and implement aggressive inspection programs to assure early detection of problems associated with the more extended useful lives now becoming common among the carriers.

As a case in point, the early group of 81 Boeing 727 aircraft operated by American have been in service between 17 and 22 years. The high time aircraft has 51,200 flight hours and 43,400 cycles. Over the years, American has accomplished three distinct major structural modification programs on these aircraft. The three programs were developed in cooperation with the manufacturer and include both structural modifications and corrosion prevention processes to ensure continued structural integrity. These programs began in 1973 and were continued through the early part of 1985.

Late in 1985 American launched a fourth life extension program for these aircraft involving still further structural modifications. In conjunction with this program, we will also replace the galleys, completely refurbish the interiors and upgrade, restore, and replace various systems and components. Our 1973–1985 structural life extension programs have cost approximately $100 million, and we estimate that the most recent program will cost as much as $13.5 million. We envision continuing investments in the structural viability of these aircraft so long as they remain in service.

As a consequence of these improvements, our direct aircraft maintenance costs on the 727 aircraft fleet have increased over the years, reflecting the cost of the restoration and rejuvenation process that has taken place. Specifically, American Airlines has increased its direct airframe maintenance costs on the 727 fleet by 55% between 1980 and 1985. CAB Form 41 data shows that even the lowest cost operators increased their direct airframe maintenance costs by 25% during this period.

Experience has shown that each airline can benefit from the intelligence provided by other operators. For this reason, we believe that all airlines operating a specific type of aircraft should participate in regular periodic review forums, conducted by the aircraft manufacturer, to examine and exchange information and technical analysis relative to the aircraft in question. These meetings would enhance the quality of the data available and enable the industry to devise ever better maintenance and modification programs in the future.

In summary, it is our view that neither chronological age nor cumulative flight hours and cycles limit the continued safe operation of an aircraft. The progressive incorporation of structural modifications, together with continuing inspection and refurbishment programs, serves to extend an airplane's useful life until its either increased operating costs or environmental considerations dictate its retirement from service. The Douglas DC-3, which was first flown in commercial service 50 years ago by American Airlines, is perhaps the best example of a chronologically old type of aircraft that is still capable of providing safe air transportation as a result of airline maintenance programs.

Senator KASSEBAUM. The next witnesses will appear as a panel. They are Mr. Cosgrove, vice president of engineering, Boeing; Mr. Warren, director of design and technology at McDonnell-Douglas; and Mr. Robertson, executive vice president, commercial products division, Pratt & Whitney.

It is a pleasure to welcome you this morning. I very much appreciate your willingness to testify and share some expertise on this subject. I think it is an important one and, as I said at the beginning of the hearing, it is one in which we are here to really learn from our standpoint here and in what ways I think we can all work together to improve the process.

Mr. Cosgrove, we will start with you.

## STATEMENTS OF BENJAMIN A. COSGROVE, VICE PRESIDENT OF ENGINEERING DIVISION, BOEING COMMERCIAL AIRPLANE COMPANY; DALE S. WARREN, DIRECTOR, ENGINEERING DESIGN AND TECHNOLOGY, DOUGLAS AIRCRAFT COMPANY, McDONNELL DOUGLAS CORPORATION; AND WILLIAM G. ROBERTSON, EXECUTIVE VICE PRESIDENT, COMMERCIAL PRODUCTS DIVISION, PRATT & WHITNEY, UNITED TECHNOLOGIES CORPORATION

Mr. COSGROVE. Thank you, Madam Chairperson. The Boeing Company wishes to thank you for the opportunity to speak to you about the structural aging of commercial aircraft. You have my prepared statement and so, rather than repeat it all, I would just like to make some brief points.

The Boeing Commercial Airplane Company recognizes its responsibility to support the air transportation system of the United States and the world with airplanes that can be operated safely throughout their lifetime. As was pointed out in the 1968 joint FAA-industry committee regarding pressurized aircraft, the manufacturer, the airline and the FAA are all critical partners in keeping the aircraft safe.

Boeing has always felt that the manufacturer of the aircraft has the knowledge from test, analysis, and previous fleet experience where to look for structural damage, and competent inspections by the airlines, regulated by the FAA, will then detect cracking and keep the aircraft safe.

This process and procedure is set into being by an approved maintenance program. I think it would be proper at this time to make sure that everybody understands that commercial aircraft are designed structurally designed with conservative margins of safety. That is, the design are based upon loads which would normally never be experienced in an airplane's lifetime, and then a 50 percent margin of safety is added.

As an example, Boeing pressure structure is designed for a minimum of 17.2 pounds per square inch, when the maximum ever expected is about 8.6 pounds per square inch inside the fuselage.

It therefore follows that commercial aircraft structure can withstand a large degree of damage and still be airworthy. I think the latest 727 bombing incident in the Near East visibly demonstrates this fact.

Maintenance and inspection programs are initially set up between the airlines, the manufacturer, and monitored by the FAA. These programs result from past fleet experience and what is known about similar design details operating in similar stress fields.

Since no two airlines operate airplanes in the same manner, such as gross weight, fuel weight, landing weight, descent procedures, and so forth, nor do the airlines inspect or maintain aircraft at the same interval of flight hours, it is then a matter of each operator developing a unique maintenance program with the FAA.

As the operator develops time on a specific fleet, he may find that some distress may show up earlier than anticipated or later than anticipated. Therefore, the program must be revised.

You may find, in the case of corrosion, some operators may inspect every two years and find minor corrosion, which is cleaned up easily at no large cost to the operator. Other operators have decided that they must go inside an airplane every year because they do not want to put an airplane down for any length of time to clean up corrosion.

The described system has shown that time after time it will uncover damage to the aircraft long before it becomes a hazard to safety of flight. It should be pointed out, although I am speaking mostly of the structure of an aircraft, all other systems, such as controls, air conditioning, electrical, and so forth, are viewed in this manner.

We believe that the existing troika system of the FAA, airlines, and manufacturers will continue to provide safety when all the players perform their function in concert with each other. This is a closed loop system which requires all participants to provide feedback so that timely corrective action may be taken. Laxity on the part of any of the parties can lead to a reduction of safety.

In your letter, Madam Chairman, you requested opinions on how corrosion affected fatigue. In my view, corrosion in metal simply reduces thickness or, in other terms, raises stress levels. In a fatigue environment, it will hasten initial cracking.

We put coatings on metals where these can be damaged, and over the years we have learned how to better protect metals by use of sealants and anti-corrosion compounds. You would find that the aircraft built today has extra protection that was not built into aircraft produced in the 1960's and the early 1970's, and therefore later aircraft do not need as much maintenance.

You should also know that many service bulletins put out by the Boeing Commercial Airplane Company are bulletins that I would call preventive. That is, bulletins which might call for modifying fastener holes by oversizing, changing a part before it cracks.

I point this out because these bulletins tend to extend the useful life of the aircraft. One could extend the structural life of an aircraft considerably by using this procedure extensively.

In summary, I would like to state that a system is in place to keep the aircraft safe. It is dependent upon the integrity, the experience, and the dedication of the manufacturer, the airline, and the FAA. I think it is a good system.

It is not perfect and may need some fine tuning here and there, but I do not know of a better system. To see if we could make the system better, we at the Boeing Company are in the process of developing a plan to increase our knowledge of selected older aircraft by working with the airlines. We are continuing to update supplemental structural inspection programs on all models.

As we continue to get data, we will issue service bulletins and change our product line to improve the serviceability of the areas that have higher than normal damage rates.

Finally, I would like to express my appreciation for the opportunity to testify on this complex issue. Thank you very much.

[The statement follows:]

STATEMENT OF BENJAMIN A. COSGROVE, VICE PRESIDENT OF ENGINEERING DIVISION, BOEING COMMERCIAL AIRPLANE CO.

INTRODUCTION—THE SAFETY SYSTEM

There is a system in place in the air transportation industry which is designed to ensure that the mature fleets of commercial air transports are kept flying safely. This system has three major participants: the manufacturers who design, build and support aircraft in service, the airlines who operate, inspect and maintain the aircraft, and the Federal Aviation Administration which establishes rules and regulations, approves the design and maintenance plans and monitors airline maintenance performance. The safety of aircraft depends on this system, and the system depends upon the skill, knowledge, diligence and cooperation of all three major participants.

My testimony today will involve discussions of:

(a) The role of each participant and some of the interplay between groups as they function to provide for a safe air transport system,

(b) The development of maintenace standards for new models,

(c) The procedures to provide for continued airworthiness of aging airplanes.

(d) How well the existing system is functioning, and

(e) New Boeing initiatives to improve airplane safety.

THE AIRPLANE DESIGNER/MANUFACTURER

Structural safety begins at the designer's board with the conception of each new model. It is built on the background and experience of all preceding models and on structural performance data gathered from fleet records from a multitude of airlines. Boeing commercial jet transports are designed to give 20 years of reliable service, with normal maintenance. Our design goal is to provide a fail safe structure for as long as an airplane is economically serviceable.

To accomplish these goals, airplane structures must be capable of performing safely in a damaged state until the damage can be detected and repaired. Airplanes operate in an environment that is hostile to metals structure. Damage from environmental attack, from fatigue cracking and from accidental causes is accounted for in the design process.

Exposure to atmospheric salts, to water, to runway contamination can cause damage to metal aircraft structure. To help preserve the structural integrity, the metals are protected from environmental damage and corrosion by application of a variety of processes, primers and paints. Although these coatings are durable, they can be inadvertently damaged during commercial service, so inspection and maintenance programs are important.

Damage may also develop from loads imposed by repeated cycles of takeoff, flight, pressurization and landing. Dislocations that exist at the molecular level in all metals form the nucleus of tiny cracks that eventually may grow and degrade structural capability. This phenomena is known as metal fatigue.

These material characteristics are well known to the structural designer. Engineers are able to determine the strength of structures that have sustained damage. They can also determine the rate at which certain damage will grow. The designer can determine how much damage is safe and how long it takes to grow to that size. The methodology exists to create designs that are durable, can function safely, and can be maintained economically.

THE FEDERAL AVIATION ADMINISTRATION

The FAA issues a type certificate of airworthiness for new aircraft models, or an amended type certificate of derivative models. Certification is granted only after the aircraft have been demonstrated, through test and analysis, to comply with the FAA regulations regarding certification. Current FAA regulations reflect the latest technology for damage tolerant design. Structure which has been damaged to detectable proportions must be capable of safely carrying extremely high loads. In airline service such loads would normally not be experienced in an aircraft lifetime. As part of the certification process the manufacturer submits analytical and test data to the FAA to verify the residual strength of damaged structures.

MAINTENANCE STANDARDS

Before an airplane is introduced into service, initial maintenance requirements are developed by a Maintenance Steering Committee made up of representatives of the manufacturers and airlines. The process is monitored by FAA specialists. This committee uses a logic decision process outlined in the Maintenance Steering Group

(MSG) handbook referenced in FAA Advisory Circular 121-22. The results are issued by the FAA in a Maintenance Review Board (MRB) report which outlines requirements for an airplane model initially starting service. Because each carrier functions in a different manner, each airline negotiates its own unique maintenance program with the FAA. The airline maintenance program must be equivalent or better than the baseline Maintenance Review Board plan. Airline compliance is monitored by an FAA Principal Maintenance Inspector. Each operators program may be revised at any time based on supportive data from his fleet and subject to FAA approval. The manufacturer also provides the airline operator with continuous maintenance planning data and includes recommended procedures for corrosion prevention.

When damage is detected in service which is not covered by procedures in the approved structural repair manual, both the manufacturer and the FAA are notified. The manufacturer will prepare and release a service bulletin if such damage could be fleetwide and could become a safety concern if left undetected. This will usually involve a special fleet inspection and a repair procedure. The FAA will release an Airworthiness Directive (AD) requiring the operator to perform the Service Bulletin procedure. If a design change is warranted, the manufacturer corrects the problem for future production units.

### CONTINUING AIRWORTHINESS

The procedure for assuring continued airworthiness of aging commercial jets has been under active development since 1968, when a joint FAA/Industry committee was formed to review the characteristics of older pressurized piston, turbo-prop and jet transport aircraft. The committee completed its work in 1970 and advisory circulars were issued providing guidance material covering structural maintenance of five airplane models. This work continued in the mid and late 70's with the formulation of procedures to extend the serviceable life of aging airplanes. Both the FAA and the CAA (United Kingdom) require that structures of older models be audited using modern technology and reflecting current service experience. When necessary, supplemental structural inspections would be required to assure timely damage detection. This procedure has been completed for the Boeing model 707 in 1979 and for models 727, 737 and 747 in 1983. A Supplemental Structural Inspection Document was published for each model and released to all Boeing operators. These inspections are now mandatory for U.S. operators under an FAA Airworthiness Directive. This effort involved a Boeing investment of over 15 million dollars and we plan future investments to extend coverage to our later models. These documents require frequent review to assure consistency with the latest fleet information on damage patterns.

The question has frequently been asked, "How old can an airplane be allowed to get before it becomes unsafe?" Most industry experts believe that as each aircraft becomes older, the frequency of damage will increase and correspondingly, the costs of inspections and repair may also increase. This trend may be halted or reversed if aging structures are rejuvenated periodically by modification programs. In any case, the existing troika system does provide safety when all players perform their function in concert with one another. It is a closed loop system which provides feedback to all participants so that timely corrective action may be taken.

### SAFETY SYSTEM PERFORMANCE

Findings of damage on older 747's have been much in the news in recent months. The extent of damage reported has been within that which the designer considered in the initial design. In each case the safety system has functioned exactly as it was intended. All damage has been detected and corrected before becoming a safety issue. Service Bulletins and Airworthiness Directives are now in preparation to cover each aircraft that approaches the damage threshold.

The overall safety record of the free world commercial aircraft fleet has been and continues to be extremely good. We continue to strive for perfection. There have been 8800 juet transporfts manufactured in the free world in the past 30 years. Boeing has produced almost 5000 of these. There are 3500 aircraft in service in the United States alone. Worldwide accident rates have fallen and have leveled out at about 2 per one million departures. Of all accidents where the cause is known, structural failure and faulty maintenance contribute less than 4% (one in ten million departures), a total of none accidents worldwide in 25 years. Of the nine only one fatality accident has been recorded within the United States.

NEW BOEING INITIATIVES

What is Boeing doing to assist the operators in maintaining the safety of its aging aircraft? We are develolping an improved plan to review the structural condition of selected high time fleet airplanes. With the airlines cooperation, we plan to provide engineers for fleet damage evaluations at convenient inspection opportunities. In addition we are continuing to update our Supplemental Structural Inspection programs to account for new cracking pattern information from fleet service and from Boeing test programs. Boeing is correlating the results of its test programs with the information that is accumulating from in-service inspections. We continue to issue Service Bulletins and make production changes to improve serviceability of areas with higher than normal damage rates. In addition, we are honing our techniques and procedures for non-destructive testing to provide operators with more reliable and more economical tools to distinguish smaller structural damage sites. We have in place publications and schools to train and certify NDI technicians in the proper procedures and most advanced techniques of non-destructive inspections.

To conclude, I believe the long term well being and surviveability of aircrft manufacturers and the main operators depends on a diligent maintenance program and continued improvement of the safety record that we have achieved. Let me repeat that the air transportation industry has a system in place to keep airplanes flying safely. This system requires the cooperation and dedication of the FAA, the manufacturers and the airlines.

Senator KASSEBAUM. Mr. Warren.

Mr. WARREN. Good morning, Madam Chairman. I am Dale Warren, director of engineering design and technology at Douglas Aircraft, a component of the McDonnell Douglas Corporation.

I appreciate the opportunity to testify before this committee. I have submitted a complete statement. I would like to highlight certain areas in that statement at this time.

A commercial airframe is designed to sustain the highest expected in-service loads, and it is also designed conservatively to be relatively trouble-free for at least its design life.

In most cases, this structural design conservatism is very significant and very beneficial. For example, the DC-9 was expected to be in service for 13 years. One of the major component development tests lasted for the equivalent of 127 years, and this component has proved to be trouble-free in service to date.

Other examples of typical design conservatism are given in my written statement in the third section, titled "key design measures."

Damage to structure occurs primarily through two means, corrosion and fatigue. In the past, corrosion has strongly dominated in-service inspection findings. Future incidents of corrosion are expected to be reduced, mainly due to the use of newer alloys with higher corrosion resistance and the use of advanced corrosion protection systems.

We expect that in future inspections fatigue should dominate because of the increasing age of the fleets and the use of improved corrosion control methods.

Corrosion-related cracking is not subject to any analytical predictions that would be useful in maintenance planning. However, it is generally more readily detectable than the early stages of fatigue cracking. The records indicate that conventional inspection programs are effective and viable for control of corrosion in service.

Fatigue cracking is subject to analytic predictions, and occurs increasingly in older aircraft. The supplemental inspection documents, called SID's, are under development in the commercial transport industry.

Douglas is developing a series of SID's to define special inspection programs for older DC-8, 9, and 10 aircraft. The purpose of these SID's is specifically to assure that safety is maintained during continued operation of older aircraft. The latest technologies of digital computing, crack growth and residual strength analyses, and non-destructive inspection are used.

The result is a program of inspections over and above the norm and specifically designed to assure timely detection and corrective action. SID's for the DC-8 fleets have just been approved by the FAA and SID's for the DC-9 fleets are nearly complete. Work has started on the DC-10 SID.

It is important that, although many of these documents have been prepared primarily by Douglas, there has been a very high level of participation and cooperation by the FAA, U.S. operators, foreign operators, and the Civil Aviation Authority of the United Kingdom.

In 1980, Douglas recognized the likelihood of extended use of the DC-9 beyond its original design life and committed considerable financial and technical resources to a special test. We competed in the used airplane marketplace and purchased a 17 year old fleet leader DC-9.

Since then, we pressure cycled the fuselage to simulate the equivalent of nearly 70 years of additional service. Two of the findings from this test are especially relevant to this hearing. Both are the result of careful monitoring of anomalies found at the beginning of the test and left as found to evaluate representative growth damage in structure.

One anomaly was a crack caused by stress corrosion. It was carefully monitored through the test and did not grow significantly. Further, the cracked part continued to perform its intended function perfectly.

A second anomaly was a small area of corrosion under an antenna with a faulty moisture seal. The corrosion served as a fatigue crack starter and also reduced the local fatigue resistance of the part.

Even with accelerated growth due to corrosion, the crack growth rate was slow enough so that the crack would have been reliably detected in normal in-service inspections without any compromise of aircraft safety.

In conclusion, I believe the following: One, the inherent conservatism in aircraft structural design allows airlines to safely operate modern aircraft well beyond their initial predicted lifetimes, providing that they are properly inspected and maintained.

Two, the supplemental inspection document concept is a technically sound and viable way to detect structural fatigue and assure continued safety of the aging commercial fleet.

Three, the mechanisms of corrosion related cracking are not subject to analytic predictions. We must continue to depend upon in-place conventional inspection and repair procedures which are adequate to control corrosion in service.

[The statement follows:]

STATEMENT OF DALE S. WARREN, DIRECTOR, ENGINEERING DESIGN AND TECHNOLOGY, DOUGLAS AIRCRAFT CO., MCDONNELL DOUGLAS CORP.

Madame Chairperson and members of the Subcommittee, I am Dale S. Warren, Director, Engineering Design and Technology at the Douglas Aircraft Company, a division of the McDonnell Douglas Corporation.

I appreciate the opportunity to testify at this hearing on the aging commercial airline fleet and its safety. The continued reliability of our commercial fleet is vital to all aspects of the future of our nation.

Structural behavior is my technical specialty and continued airworthiness is a special interest. I would like to emphasize four particular areas: (1) key design measures, (2) typical inspection findings, (3) special measures for extended service life, and (4) a special test of DC-9 fuselage No. 3.

KEY DESIGN MEASURES

A commercial airframe is designed to sustain the highest expected in-service loads. It is also designed conservatively to be relatively trouble-free for at least its design life. In most cases this structural design conservatism is very significant and very beneficial. For example, the "Queen of the Fleet," the DC-3, was developed using technologies of the 30's with only an appreciation of metal fatigue. This design is more than fifty years old and many of these aircraft are still performing well and are in high demand today.

The predicted service lives of the DC-8, -9, and -10 aircraft were verified in design primarily by tests of actual aircraft structure. Certain highlights of this conservative design approach should be valuable to the perspective of this hearing.

The DC-8 was expected to be in service for twenty years. The design development included fatigue cycling of a forward fuselage for the equivalent of 112 years, or nearly six lifetimes. Then, while under full cabin pressurization, the fuselage was repeatedly "harpooned" by a 15-inch wide blade through the sidewall to detect any latent weakness due to fatigue exposure. No weakness was found.

The DC-9 was expected to be in service for thirteen years. One of the major component development tests lasted for the equivalent of 127 years, or nine lifetimes. This component has proven to be trouble-free in service.

The DC-10 was expected to be in service for twenty years. One of its fuselage panel development tests involved fatigue exposure combined with overload. After two lifetimes, or 40 years, of fatigue exposure, the panel exhibited a small, but visible crack. After the equivalent of 12 more years of realistically simulated service the crack had grown to just three inches. Only after five more equivalent years of abuse (repeated 150% overload) did the crack grow to the fail-safe design length (40 inches for this case) and even then failure did not occur until a 200% overload was applied. Had this crack occurred in actual service, it would have been detected and repaired long before reaching its fail-safe limit.

Although these examples are somewhat tedious, they should clearly demonstrate the conservatism employed by the manufacturer in the fatigue design of the commercial fleet. This conservatism translates directly to reserve life and safety.

TYPICAL INSPECTION FINDINGS

Damage to structure occurs primarily through two means—corrosion and fatigue. In the past, corrosion has strongly dominated in-service inspection findings. Future incidents of corrosion are expected to be reduced mainly due to the use of newer alloys with higher corrosion resistance and the use of advanced corrosion protection systems. We expect that in future inspections, fatigue findings should dominate because of the increasing age of the fleets and improved corrosion control methods.

Corrosion related cracking is not subject to any analytical predictions that would be useful in maintenance planning. However, it is generally more readily detectable than the early stages of fatigue cracking. The records indicate that conventional inspection programs are effective and viable for control of corrosion in service.

Fatigue cracking is subject to analytic predictions, and occurs increasingly in older aircraft. The Supplemental Inspection Documents (SID's) under development in the commercial transport industry, which establish inspections beyond those required during normal maintenance, are a proper approach to timely detection and repair of fatigue cracks,

SPECIAL MEASURES FOR EXTENDED SERVICE LIFE

To the best of my knowledge the industry/FAA first took specific action to address the concerns of aging aircraft in the late 1960's. The DC-8 High Time Aircraft

Report is an example of the resulting plan. It was based on service experience provided by the operators to Douglas because this was the best information available with the technology of that time.

Since then, technology developments have provided the key ingredients to a predictive capability that is the basis of a new science—some call it "crack management"—to find and correct any structural anomalies before they become significant. By whatever name, the science is being adopted in the US and abroad by managers of military and commercial fleets. Douglas is developing a series of SID's to define special inspection programs for older DC-8, -9, and -10 aircraft.

The purpose of these SID's is to assure that safety is maintained during continued operation of older aircraft.

The latest technologies of digital computing, crack growth and residual strength analysis, and non-destructive inspection (NDI) are used.

The result is a program of inspections over and above the norm, specifically designed to assume timely detection and corrective action.

SID's for the DC-8 fleets have just been approved by the FAA. SID's for the DC-9 fleets are nearly complete, and the basic DC-10 data is in work.

It is important to note that although these documents have been prepared primarily by Douglas, there has been a very high level of participation and cooperation by the FAA, US operators, foreign operators, and the Civil Aviation Authority of the United Kingdom.

## DC-9 FUSELAGE NO. 3 TEST

In 1980 Douglas recognized the likelihood of extended use of the DC-9 beyond its original design life and committed considerable financial and technical resources to a special test. We competed in the market place and purchased a 17-year-old fleet leader DC-9 aircraft with 66,500 flight cycles, the third DC-9 built. Since then we pressured cycle the fuselage to simulate an additional 142,000 cycles, for a total of 208,500 flight cycles, the equivalent of nearly 70 years of service, or 5.2 lifetimes. In addition, extensive special inspections have been performed to detect incipient cracking, and further testing is in progress to similarly evaluate representative wing and empennage structure. Two of the findings from this test are especially relevant to this hearing.

Prior to laboratory testing, the test article was carefully inspected to identify any anomalies resulting from the 66,500 flights of normal service. Nine items, including two corrosion areas, were found and repaired, just as they would have been in normal in-service maintenance. Five were left as found to grow and provide data on in-service crack growth rates. Of these, three grew an inconsequential amount during the additional testing equivalent of more than 40 years of normal service.

A fourth unrepaired crack was caused by stress corrosion (cracking due to combined effects of stress and corrosion). It was carefully monitored throughout the test and did not grow significantly; further, the cracked part continued to perform its intended function perfectly.

The fifth unrepaired section was a small area of corrosion under an antenna with a faulty moisture seal. The corrosion served as a fatigue crack "starter" and also reduced the local fatigue resistance of the part. Even with accelerated growth due to corrosion, the crack growth rate was slow enough so that the crack would be reliably detected in normal in-service inspections without compromise of aircraft safety.

## CONCLUSIONS

1. The inherent conservatism in airframe structural design allows airlines to safely operate modern aircraft well beyond their initial predicted lifetimes providing that they are properly inspected and maintained.

2. The Supplemental Inspection Document (SID) concept is a technically sound, and economically and practically viable way to detect structural fatigue and assure continued safety of the aging commercial fleet.

3. The mechanisms of corrosion related to cracking are not subject to analytic predictions. We must continue to depend upon in-place conventional inspection and repair procedures which are adequate to control corrosion in service.

Senator KASSEBAUM. Thank you, Mr. Warren.

Mr. Robertson, I think we will go along, hear all three comments and then ask questions of all of you. Mr. Robertson.

Mr. ROBERTSON. Madam Chairman, good morning.

I am Bill Robertson, executive vice president of the Commercial Products Division of Pratt & Whitney, a unit of United Technologies Corporation. Pratt & Whitney in the world's leading designer, manufacturer, and supplier of jet engines for commercial aircraft.

I am prepared to summarize my statement, but I would appreciate my full statement in the record.

Senator KASSEBAUM. That will be done.

Mr. ROBERTSON. We have been asked to discuss the aging commercial fleet, but I think that the real reason that we are all here today is because of the growing perception that air travel is not safe. That is not true. Air travel is safe, and a lot of people are being frightened unnecessarily by those who say otherwise.

Commercial air travel is by far the safest form of transportation there is. While we can cite an outstanding safety record, I must emphasize, however, that any fatality, even one, is too many.

There are more than 19,000 Pratt & Whitney engines in airline service today, and more than 12,000 of them are JT8D's. The 8D is the most widely used engine in commercial aviation. It has an outstanding safety record and it continues to set industry standards for reliability.

A JT8D-powered jetliner takes off somewhere in the world every five seconds, or some 18,000 times a day. More than 1 million people board these aircraft every day and arrive safely at their destinations.

Given the enormous numbers involved, billions of passengers, hundreds of millions of hours, millions of flights every year, and in over 20 years of service there have been only three fatal aircraft accidents in which the JT8D was even suspected of being the cause, and two of these are still under investigation.

A well maintained jet engine does not have to be replaced because it is too old. Our engines are designed to be rebuilt to an as-new condition many times during their lives. There is no end to the useful life of a jet engine from a safety standpoint.

The airlines continually monitor their engines. They go through rigorous maintenance procedures. We continue our engineering efforts after certification throughout the service life of the engine to provide further improvements. Even so as the fleet matures the reliability continues to improve.

Flight safety has always been the number one priority job at Pratt & Whitney. We lay the foundation for safety in a Pratt & Whitney engine at the very beginning, when we design it. This is followed by an intensive development program, which takes several years to complete.

FAA certification testing is the final step along the road to actual airline service. In the FAA certification process, the engine and its components may be subjected to as many as 75 individual tests, some of which include operational conditions more severe than the engine will ever see in service. Other tests include ingestion of ice slabs and birds.

Once certified, an engine comes under the control of the airline. The airline maintains the engine in a shop certified and licensed by the FAA, using procedures and standards recommended by the engine manufacturer and approved by the FAA.

For mature engines, the standards are the results of individual airline experience combined with recommendations from the manufacturer. The FAA is the final approval authority.

We are constantly reviewing airline service experience to ensure the highest possible levels of safety. There's a continuous flow of information among engine and aircraft manufacturers, airlines, overhaul shops, and the FAA. Most important, though, is the fact that by every measure we use engine fleet reliability has continued to improve through the past 10 years, including the time since deregulation.

There are engines flying today that were produced more than 20 years ago, and they are even more reliable now than the day that they were built.

But we cannot stop there. In any endeavor, there is room for improvement, and ours is no different. We are constantly looking for ways to improve. In recent months, working with The airlines, the NTSB, and the FAA, we have taken five new maintenance actions relating to the JT8D, including new burner can inspection requirements and mandatory replacement of certain compressor spacers.

In conclusion, our industry has a good system in place, but like any system it needs periodic fine tuning. The important thing is, however, that it works and it works well.

[The statement follows:]

STATEMENT OF WILLIAM G. ROBERTSON, EXECUTIVE VICE PRESIDENT, COMMERCIAL PRODUCTS DIVISION, PRATT & WHITNEY, UNITED TECHNOLOGIES CORP.

Good morning.

I'm William Robertson, executive vice president of the Commercial Products Division of Pratt & Witney—the world's leading designer, manufacturer and supplier of jet engines for commercial transports. We are a unit of United Technologies Corporation.

In my job, I'm working day to day in support of the world's commercial airlines, and I've been with Pratt since the beginning of the commercial jet age.

There's a growing perception that air travel isn't safe. I'm here to say, that's not true. Air travel is safe and a lot of people are being frightened needlessly by those who say otherwise.

Commercial air travel is the safest form of transportation there is. The Department of Transportation has made some comparisons. Did you know, for example that:

It's safer to fly 35,000 miles in a commercial jet than it is to drive 300 miles in your car?

I don't mean for a minute to minimize what's happened in commercial aviation this past year.

While we can cite an outstanding safety record, I must emphasize that even one fatality is one too many.

We've been asked to discuss the aging commercial fleet, but the real question is: "Is it safe to fly?"

If I'm able to do nothing else this morning, I hope I can at least bring some perspective.

There are more than 19,000 Pratt & Witney engines in airline service today. These engines power Boeing 707s, 727s, 737s, 747s, 757s, 767s; McDonnell Douglas DC-8s, DC-9s, DC-10s and MD-80s; and Airbus Industrie A300s and A310s—among others.

More than 12,000 of these engines are JT8Ds. The 8D—in its various models—is the most widely used engine in commercial aviation. Because of two accidents last year involving JT8D-equipped aircraft—in Manchester, England and Milwaukee, Wisconsin—the JT8D received widespread notoriety.

The investigations are not yet complete and the causes of the accidents are not determined.

The JT8D is a remarkable engine with an outstanding safety record.

The JT8D alone has been responsible for bringinig commercial jet transportation to smaller cities and towns all over the world. It literally changed the world's transportation patterns.

Every five seconds, a JT8D-powered jetliner takes off somewhere in the world. Since it entered service in 1964, it has flown more than 285 million—that's 285 million—hours.

Around the world, aircraft with JT8Ds take off nearly 18,000 times every day and arrive safely at their destinations.

These engines accumulate 17 million flight hours a year, and continue to set the industry standards for reliability.

I know statistics can be numbing. But please consider: Given the enormous numbers involved—billions of passengers, hundreds of millions of hours, millions of flights every year—there have been only three fatal aircraft accidents in which the JT8D was even suspected as being the cause. Two of these are still under investigation.

There's been a lot said and written lately about the aging commercial fleet. What about "old" engines?

The average age of a JT8D in service today is about 25,000 hours—that's equivalent to about 10 years of service. Of course, some of the engines are brand new. The eldest have flown some 60,000 hours.

But with jet engines, old doesn't mean broken down.

Your automobile engine—even if it's meticulously maintained—eventually wears out and you buy a new car. You may get 100,000 miles out of that engine. That's equivalent to driving 50 round trips across the country.

It's not the same with a jet aircraft engine. If you maintain a jet engine properly you never have to replace it because it's too old. Proper maintenance keeps it "young".

Our engines are designed to be rebuilt to an "as new" condition many times during their economic lives. In essence there is no end to the "useful" life of a jet engine from a safety standpoint.

The airlines continually monitor their engines. They replace worn parts and those which have a specific life limit. As we develop new technology, parts are upgraded. Airlines routinely perform preventive maintenance. Industry statistics tell the story. Even as the fleet matures the reliability improves.

One way to measure an engine's reliability is what we call the in-flight shutdown rate; how often a pilot has to shut down an engine—for any reason—in flight.

When the JT8D was new, and there were relatively few of them in service, an engine was shut down an average of about once in every two years of service.

Now, with more than 12,000 engines in the fleet, and in service for more than 20 years, an engine is shut down about once every 13 years. Aircraft are still safe to fly, even with an engine out, and are certified by the FAA to do so.

Another mearsure of reliability is how many times an airline has to take an engine out of service before it planned to.

In 1975, the unplanned removal rate for the 8D was equivalent to once in every two years of service. Today, it's once every three and a half years. Better today than it was 10 years ago.

Still another way to describe this reliability is: There are engines flying today that were produced more than 20 years ago and they're even more reliable today than they were when they were built.

Indeed, the JT8D and the other of our engines in the commercial fleets continue to improve their reliability and safety rates every year.

I'm not suggesting that you don't have to buy new engines. But you don't buy them because the ones you're flying are worn out. You but new ones because newer technology engines give you better fuel efficiency, lower noise levels, less emissions and better overall economy.

A minute ago, I said aviation is the single safest mode of transportation in the world.

There's a reason for it. In the aviation industry, whether you're an engine manufacturer, an aircraft builder or an airline—there's a priority that overrides every other consideration. That priority is safety.

Everything we do, from design, to manufacturing, to testing, to supporting our products in the field, is based on that single priority—safety.

We establish the safety of a Pratt & Whitney engine in the very beginning—when we design it.

Typically, an aircraft engine development program—that's from design through introduction into service—is arduous. We and the FAA put a lot of demands on the engine. We repeatedly push it to the operating limit and beyond. Safety is the number one consideration in every stage of the program.

By the time an engine begins certification testing, it has endured thousands of hours of component ring testing, sea level and altitude testing, and development flight testing. The development test program alone takes about three-and-a-half years, and tells us the engine works and how well. This very rigorous test program validates not only the original design, but also the manufacturing and technology used to produce it.

Certification testing is the final and perhaps the most difficult step along the road ot actual airline service. We're going through certification testing now for our newest commercial engine for wide-body aircraft.

In that program, the Federal Aviation Administration requires the new engine to pass 75 separate tests—including 24 engine tests, 19 rig tests, and 32 component tests.

The tests measure the safety, operability and reliability of the new engine. Some are routine, others extreme. All are exacting and extremely demanding.

During certification testing, an engine must demonstrate acceleration and stable operation at sea level and high altitude. It must be able to shift from idle to takeoff power a thousand times in rapid succession.

It must prove its endurance during a 150-hour test that literally pushes the engine's limits. The FAA requires us to run tests that far exceed what the airlines will see in service.

One of the most dramatic and critical things we do to ensure safety is a series of foreign object ingestion tests. We shoot water, ice slabs, hail, and birds into a series of engines running at full power.

FAA regulations say an engine must be able to ingest ice slabs, hail and water without a sustained loss of thrust. The FAA also demands that an engine be able to withstand a bird strike simulated by the simultaneous ingrestion of up to eight one-and-a-half-pound birds without losing more than 25 percent thrust.

In addition, the FAA requires an engine to ingest a four-pound bird and also suffer a broken fan blade and shut down safely.

In addition to such potentially catastrophic events, the FAA requires an engine to meet many other performance tests, involving such areas as the ignition system, gearbox, and lubrication and control systems.

We run tests to help us determine maintenance needs and component part lives.

For each of the 75 tests required by the FAA, the engine manufacturer has to submit a detailed report verifying the test data and results. FAA representatives observe the tests, review the test results and inspect engine parts before and after tests are completed.

After all the testing is completed, reports are submitted and reviewed, and results are discussed.

If the FAA is satisfied the engine has met the standards and meets all of the "proof tests," the agency issues a type certificate. The development process—from design initiation to certification—takes nearly six years. Then, the engine and the aircraft must pass an equally rigorous aircraft certification process before any passengers can be carried.

When we deliver an engine, we are required by the FAA to provide installation and operating instructions and instructions for the continued airworthiness—or safety—of the engine. Those instructions include maintenance and overahaul manuals.

Once certified, an engine comes under the control of the operator, in most cases an airline. The operator maintains the engine in a shop certified and licensed by the FAA, using procedures recommended by engine manufacturers and approved by the FAA.

Maintenance procedures—or standards for new engines—are developed initially by an Industry Maintenance Steering Group, composed of manufacturers and airlines. The FAA's Maintenance Review Board reviews the Steering Group's recommendations, and issues an official maintenance program document that the airlines must follow.

For mature engines, like some models of the JT8D, the standards are the results of individual airline experience combined with recommendations from the manufacturer. Our recommendations will encompass areas like part life limits, maintenance planning guidelines and corrective action for known service problems.

After the certification process, the engine continues to be improved. The FAA requires that we report all significant "failures, defects and malfunctions" that occur with any of the engines. Sometimes we do find some operating problems. How do we handle these?

Our on-site Pratt & Whitney field representatives submit reports.

The airlines and overhaul shops direct information to us.

We meet regularly with our operators on engine service experience.

The FAA also provides input.

We monitor reliability statistics—shop visit, removal and in-flight shutdown rates.

We do engineering investigations of parts used in service.

When a service problem is uncovered by any of these methods, we have several established vehicles to communicate with the airlines.

All-operator correspodence—advisories and recommendations. These are wires or letters that alert operators to aircraft/engine incidents. We follow these wires with recommended action.

Service Bulletins—specific recommendations on maintenance procedures or hardware improvements. For example, if there is a service problem that requires a new periodic inspection terchnique, the service bulletin will tell the operator when and how to do it.

Revisions to manuals. We regularly send operators updated pages to add to their official maintenance manuals.

Industrial meetings—convened to address specific problems and update procedures. In September, for example, all JT9D operators will meet in Hartford to discuss engine maintenance.

There is a continuous flow of information among engine manufacturers, aircraft manufacturers, airlines, overhaul shops and the FAA.

Any time there's a change in the configuration of the engine—its design—we must have the change approved by the FAA. For example, whenever we put out a Service Bulletin describing a modification, the FAA first has to approve the engineering change described in the bulletin.

We constantly are reviewing field correspondence to ensure the highest possible levels of safety.

The system is designed for foster communications. Each manufacturer and airline has internal procedures developed over a long period of time which complement those of the others. No single part of the system can or should function alone.

By every measure we use, fleet reliability has continued to improve through the past 10 years. But we can't stop there.

In any endeavor, there's room for improvement, and ours is no different; we're constantly looking for ways to improve.

For example, we have an internal safety review process in place at Pratt & Whitney to review all incidents involving our engines.

In recent months working with the airlines, the NTSB, and the FAA we have taken five new maintenance actions relating to the JT8D, including new burner can inspection requirements and mandatory replacement of spacers.

This review serves further to focus our continuous flow of communication among manufacturers, airlines and the regulatory and investigative agencies.

Recently it has been suggested that the FAA convene a special Maintenance Review Board. If such a board is convened, Pratt & Whitney will cooperate fully. Such a review board should comprise appropriate federal agencies, the engine manufacturers, the aircraft manufacturers, the airlines and the overhaul shops.

Any safety benefits that such a board might contribute would be enhanced if a one time review of maintenance practices on all engines in commercial airline service was made on a generic basis, rather than limiting the scope to a single engine model.

Our industry has a good system in place. Like any system, it needs periodic fine tuning. The important thing is that it works and it works well.

Senator KASSEBAUM. Thank you very much, Mr. Robertson. I would agree with you. I think it does work very well, and we should not lose sight of that, except that we need to, as you say, maintain vigilance in making sure that we do all that we can to enhance the continued success of that operation.

I have several questions. I think I will start with you since you ended last. Regarding your program, on February 5, 1986, during a walk-around inspection of a Boeing 727 a hole was discovered in the number one engine cowling. Further examination showed extensive cracking in all the combustion chambers.

This engine was being maintained on an engine condition monitoring program. The NTSB has recently made suggestions on the ECM program. In your experience, I wonder if you would discuss the limitations of the ECM program and what changes you would recommend?

Mr. ROBERTSON. Well, first of all, let me say that an ECM program is a program in which a number of parameters on the engine are constantly monitored while the engine is in operation in flight. Certainly it is useful tool in detecting and analyzing any situation that develops on the engine where it deviates from the norm.

Now, there is no system that is absolutely complete in itself, that is absolutely 100 percent reliable in predicting faults that might develop. But we believe that the ECM system along with guidelines that have recently been worked out as to how the system is used and maintained and how the operators of that system are to be qualified for its use will certainly be a big step in improving flight safety.

Senator KASSEBAUM. When you issue a service bulletin recommending maintenance procedures on hardware improvements, the service bulletins are not mandatory on the operators, are they?

Mr. ROBERTSON. They are not mandatory. They are recommendations made by the engine manufacturer, in this case Pratt & Whitney, as our recommendation to the airline as to some maintenance action that should be taken, whether it be an inspection program or a part refurbishment program or a part replacement.

The airline makes the final judgment as to whether or not the change is made, pending action by the FAA.

Senator KASSEBAUM. Pending action by the FAA? The FAA can take action if they believe it necessary?

Mr. ROBERTSON. If they see so fit, they can take action. Otherwise it is a recommendation made by the engine manufacturer to the airline, who evaluates it and, within the scope of their plan, will make that decision.

Senator KASSEBAUM. Do you feel any responsibility for following through on any recommendation you have made in the service bulletin?

Mr. ROBERTSON. We track the recommendations very closely, to the best of our ability. Of course, we are not part of the maintenance operations. That is the airlines' affair. And while we are there to help and to provide any instructions or recommendations we can to help the maintenance plan, we do not monitor it from a standpoint of directing them what to do. That is not our position, it is not our prerogative.

Senator KASSEBAUM. When the FAA makes a service bulletin mandatory by issuing an airworthiness directive, does Pratt & Whitney have any input in making that determination?

Mr. ROBERTSON. It is usually started by a recommendation that Pratt & Whitney makes, taking into account the particular problem in question and our analysis of the situation, past history, in case there have been previous events. We look at the fleet, the age of the engines, if part life criteria is in question, and those recommendations are usually issued as a service bulletin, and they are also discussed with the airlines and with the FAA, very often in an industry meeting.

Senator KASSEBAUM. There has been some question of why there has been seemingly a long time lag between acknowledgment of a problem, comments in the service bulletin, and the issuance of an AD. Is this just a given as part of the process, or do you feel that perhaps the FAA has been tardy in expeditiously following through?

Mr. ROBERTSON. Well, it is very difficult to look back in the past and critique events that have taken place, because it is speculative in nature. I will not criticize the FAA for the position that it has taken, because I believe it did what it thought was right at the time.

Senator KASSEBAUM. The NTSB has recommended the FAA convene a maintenance review board to review the maintenance reliability programs under which the Pratt & Whitney JT8D engines are being operated. Do you agree with this recommendation?

Mr. ROBERTSON. Well, we will certainly contribute whatever we can to the success of such a board if it is formed. We believe the board should consist not only of members of the appropriate Federal agencies, but the engine manufacturers' representatives, air frame representatives, airlines, and overhaul shops.

We believe that the contribution such a board can make would be greatly enhanced if a one-time review were made of all engine maintenance practices on a generic basis, as opposed to simply a look at the JT8D.

Senator KASSEBAUM. I would share that view.

There have been several engine failures from the rupture of the high pressure compressor spacer and 47 incidents of spacer fractures from 1978 to the present. Between 1978 and 1981, Pratt & Whitney issued a series of letters to operators and held conferences to disseminate new inspection and repair techniques.

An AD was not issued until January 1986, and there are now questions of whether this is adequate. Could you please comment on this situation? This was really what I had in mind when I asked if there was not a time lag between the time a problem was first discovered and when an airworthiness directive was finally issued.

Using that specific incident, can you give us any idea of ways that this could be improved?

Mr. ROBERTSON. Well, I think some of the situations do seem to take a lot of time, but I think in looking at what we have facing us, when we have an engine problem that occurs in the field, again we have to look at, first of all, the fleet to sort out which engines have the part that's in question. We have to look at the types of engines that they're operating.

There are over 10 different types of JT8D engines. It's not just one engine. There are many different types. There are many different ages. And there are differences in part configuration.

So, we have to look at the fleet and determine what parts are required to be replaced, what inspection requirements are required for each engine model, and of course, we have to take into account the supply of parts that would be necessary to replace the number of parts that are in the field that any directive would state should come out.

So, it's a lengthy process requiring—it's not so much waiting, but a lot of data has to be collected, analysis has to be made, and plans have to be laid down at the manufacturer and at the airlines where this all can be carried out.

Senator KASSEBAUM. It seems to me you were very conscious of problems between 1978 and 1981 when you were disseminating a considerable amount of information, and with 47 incidents between '78 and the present it seems to me that there was bound to be a large amount of evidence that was being accumulated at that point. To not to have an AD issued until 1986 given this amount of evidence, I find troubling.

As you well know, the suspected cause of engine failure in the Midwest Express accident in Milwaukee in September of 1985 was this very problem. That is not a matter of record at this point and I don't want to get into the specifics, but, I would like to know if it took that to get an AD, and why, with obviously your efforts and the number of incidents that had occurred and been reported, was that so long in coming?

It seems to me that is something that has to be answered. I don't know that it's Pratt & Whitney that needs to answer it, but somewhere along the line it seems to me that that is a good illustration of where we can improve the process.

In your testimony you stated that once certified, an engine comes under the control of the operator and the operator maintains the engine is a shop, certified and licensed by the FAA, using procedures recommended by engine manufacturers and approved by the FAA.

In the hearing held by the NTSB on the Milwaukee Midwest Express crash, a Pratt and Whitney customer maintenance engineer testified in regard to shop reviews: "What I said to you was in general for all shops. I don't believe that in the past five years I have looked at a single shop that would survive close scrutiny by the FAA to their requirements, particularly in the area of calibration of instruments. I don't go into a single shop that I can't walk around the shop and pick up an instrument that's not out of calibration, or I should say, not out of calibration date."

I wonder if you would comment on the quality of maintenance performed by these FAA-approved shops.

Mr. ROBERTSON. Well, I guess I can only go back to the record. The JT8D has flown 285 million hours, and we think its safety record really has been unsurpassed over the last 22 years, so I believe that the airlines' maintenance programs are not all bad. I think they're doing something right.

But that doesn't say they can't be improved, and if you're looking at any particular shop at any particular time, there may be things that could be changed or improved. I don't feel qualified to comment on the general condition of the airline shops because we don't monitor those.

Senator KASSEBAUM. Thank you, Mr. Robertson.

Mr. Warren, you in your testimony did bring us up to date on the SSID program, and what McDonnell-Douglas is planning to do regarding completion of those for your planes. Do you plan in your SSID program to use the candidate airplanes approach which Boeing uses, and do you think if you plan to do so, that random sampling of models of aircraft is sufficient?

Mr. WARREN. There are a few differences between our program and the Boeing program, and one of the differences is that we emphasize the use of sampling.

Senator KASSEBAUM. I'm sorry, you emphasize what?

Mr. WARREN. One of the differences is that we emphasize the use of sampling. It is not a hard time inspection with a threshold as in older inspection programs.

It takes full advantage of the statistical approach and actual fleet utilization to identify where to best sample, to avoid airplanes that are sheltered for some reason by special service, to insure that the highest time airplanes are inspected and to avoid extreme or unfair economic burden on any individual operators.

Senator KASSEBAUM. Do your SSID programs that you will be designing address the problems of cracks originating in areas that are not accessible without removal of its skin?

Mr. WARREN. Definitely. Our program is based on the concept of detecting cracks, depending upon their criticality, and totally independent of their accessibility. The approach in the design of the program is to find inspection procedures that minimize the costs, considering both tear-down costs and equipment purchase costs.

Some inspections are done in place using special techniques to effectively look through the skin. Others require partial disassembly. Usually this means to remove interior elements to allow access to the inside of the airframe. We try to provide options so that operators can choose the procedure that best suits their situation.

Senator KASSEBAUM. Now, McDonnell Douglas, according to my understanding, will complete their supplemental structural inspection program between what, 1986 and 1988?

Mr. WARREN. Our DC-9 should be complete within the year, and our DC-10's probably will be done before 1988.

Senator KASSEBAUM. Has there been any particular reason why you have been this long in completing your program? Did you feel that the current maintenance efforts were sufficient?

Mr. WARREN. Several factors are a part of the decision that led to this schedule. One is that very special skills are required to do this kind of work, and the number of skilled people available in the industry is small, and so, significant training has been required.

Another factor is that our procedures involve the use of some new inspection techniques. These had to be evolved over a period of time. Some of them have been done with special support by foreign operators and travel to their facilities.

Another consideration was that we felt there was a significant advantage to investing part of our resources to our DC-9 fuselage No. 3 test. We feel that this was a very significant suportive element to our SID program. It provides more realism and reliability to our SID analysis and inspections.

All these things led to the program schedule we have, and these schedules are such that the DC-10 program will be complete before these airplanes reach the time of any possible risk.

Senator KASSEBAUM. Thank you very much.

Mr. Cosgrove, Boeing has in the past funded several tear-down inspections of high time 707's to monitor aircraft structure.

Mr. COSGROVE. Yes.

Senator KASSEBAUM. Has Boeing done any similar type of tear-down on its other models of aircraft since these models are beginning to reach their design objectives?

Mr. COSGROVE. No, we haven't, Madam Chairman. We've taken a view that if you take an airplane, it's a single specimen. It may be an average, it may be better than average, or it may be worse than average. So, we've taken the view that we would rather spend our resources going out and looking at a number of high time airplanes rather than looking at a single aircraft.

We did find that when we took a look at the TWA 707 way back in the early 1970s and tore it down, that it looked pretty good. Our view of it was, well, so what did we learn out of it? So, we decided that rather than do tear-downs, we would rather go out to the fleet and look at the high-time aircraft.

Senator KASSEBAUM. Are the fail-safe design practices of the 1950s and 1960s on such aircraft as the 727, 37 and 47, adequate, do you think today, to insure safety as they reach the design objectives?

Mr. COSGROVE. Yes.

Senator KASSEBAUM. You still feel fairly confident of that?

Mr. COSGROVE. Yes, I do firmly believe that. Yes, I think that—well, I've got to go back a few years. I started in the industry when the comet aircraft came out of the sky and due to fatigue they weren't designed fail-safety.

I think most of the commercial aircraft manufacturers after that time just plain decided that we had to have fail-safety in our aircraft, and they had this—the model fail-safety that they had to have was to be able to detect those cracks before they became dangerous.

I think everybody has been following that concept ever since that time. I think they have lots of fail-safety in them, yes, I do.

Senator KASSEBAUM. Following on that, in 1977 a Boeing 707 crashed in Zambia.

Mr. COSGROVE. Yes.

Senator KASSEBAUM. The horizontal stabilizer failed because, it is my understanding, of fatigue cracks in a rear spar?

Mr. COSGROVE. That is correct.

Senator KASSEBAUM. Does this accident in your mind raise some doubts about the reliability of the fail-safe design concept?

Mr. COSGROVE. After a lot of review of the stabilizer coming off at Lusaka, I think we came to the conclusion that we felt that we had misjudged the amount of shear that you could take out of a member and carry into another member for fail-safety.

At that time we went and we reviewed all of our fail-safe concepts, and this was the only case that we knew at the time, and since that time, where we did have that particular problem.

Senator KASSEBAUM. And since that time you have not had that problem?

Mr. COSGROVE. No, no. It was a single incident, and at that particular time——

Senator KASSEBAUM. Because of—I'm sorry, why was it—shear?

Mr. COSGROVE. We had a concept of shear transfer from one member to another, and depending on the length of the member that you had to transfer the load. The length of the member decided whether or not you could safely do that. We went back and reviewed all the other fail-safe members and found out that that was not the case.

That is there's no such thing as an isolated case, but in this case we did believe it was, very similar to the JAL accident that was mentioned earlier.

Senator KASSEBAUM. Cracks have been found in the fuselage frame on 747 aircraft. According to the fail-safe design concept, the skin is the fail-safe load path which can hold all the loads until the cracks are discovered.

Have you ever tested the skin after frame cracking to determine whether that load path would hold up as long as expected in theory?

Mr. COSGROVE. We've done many tests where we've thrown knife blades through fuselages, which would instantaneously sever the skin and the frame behind it at the same time, maybe two frames. We've had cases where we've had 75 inches of skin cracking and the frames will take the load. And it depends upon what you want to call a fail-safe member, the skin or the frame.

We believe that we have plenty of evidence that shows that there's lots of fail-safety. In the particular incident which you're talking about, I think the surprise to us, if any, was not that the frames were cracked. It was more that there were three, one right after the other.

We would normally have expected that we might have seen some skin distress after one single frame was cracked. That did not occur, and that's when we came out with a service bulletin and finally we ended up with an AD note on the aircraft.

The airplane was fail-safe at the time. It would take more than the pressure load that was required. Most people don't—they say just the skin was left, but there was a tear strap left also at each frame location. So, it was still fail-safe.

Senator KASSEBAUM. So, you have absolutely no question that the theory does hold up under testing?

Mr. COSGROVE. I have no question about the theory whatsover. It got a lot of notoriety in the newspaper. I'm a little bit disappointed that it did. But as far as I'm concerned I wouldn't mind flying those airplanes, no.

Senator KASSEBAUM. I have a couple of questions for all three of you. One is, are there any areas of aircraft maintenance inspection which you believe requires stricter standards by the FAA to insure the safety of aircraft?

Mr. Cosgrove, we will start with you.

Mr. COSGROVE. No. I think the process is working well. I was interested earlier, in listening about getting more FAA inspectors, when Mr. Broderick was speaking. I have no opinion of that, as to whether they need more inspectors or not.

I would think if inspectors are going to go out there and help inspect the airplanes or look around airplanes, or make sure that they are helping look at the right things with the airlines. I think that is a good thing to do.

If we're going to go out and invent some more paperwork, I don't agree with it. But I do believe that people in and around airplanes with eyes, just looking around, tend to find a lot of things that you normally wouldn't find even by direction. So that, you have to have people around an airplane. That's all I have to say on that.

Senator KASSEBAUM. Mr. Baker of American mentioned a review forum where all of the operators and the manufacturers have the opportunity to share information—do you think this would be useful? I know the manufacturer, as he pointed out, does this with his customers.

Mr. COSGROVE. Madam Chairman, I think we had better straighten this one out. We have these meetings regularly, and we invite all the operators. What we do is—it may be on a structures issue and it may be on a particular model, we invite questions approximately two months beforehand from all operators.

We end up by answering the questions, and in some cases where we can't answer them we end up by having—by putting the question to the floor. The last meeting that we had it was on section 41 of the 747. We had 65 operators. We have those regularly, and they do help the operator find out what the other people are doing one way or another and what kind of distress they're having. Yes, we do have those regularly and it's a very good forum.

Senator KASSEBAUM. Do you have any recommendations for improving the system between the manufacturers and the users by the FAA?

Mr. COSGROVE. No, I don't. No, I think the system is working very well.

Senator KASSEBAUM. Mr. Warren?

Mr. WARREN. Yes, I have one comment on that particular point. The Douglas system for SIDs, incorporates the idea of statistical evaluation of inspection findings. This makes it important to have good reporting of all of the information determined in the inspections around the world.

Many of the older airplanes are finding homes outside the United States, and it is important to everybody to have more emphasis on feedback from all the operators. I think the FAA could help make that work.

Senator KASSEBAUM. Mr. Robertson?

Mr. ROBERTSON. I think I will agree with what has been said already. Actually, communications is a very important part of our whole process. We have some airlines that have flown aircraft with our engines for many, many years and we have others who have just started.

It is a good thing to have happen for the airlines that have been in business with those aircraft for a long time to be able to communicate their experience to the newer airlines. You see, the airline people work very well together. They don't withhold secrets when it comes to safety of operations or maintenance operations.

So, I think we have to make every opportunity for them to get together and discuss their items of mutual interest.

Senator KASSEBAUM. Well, as I asked Mr. Broderick, one of the concerns that has been raised through other hearings, is perhaps too close a working relationship between the inspectors and those they are inspecting. The possibility of loss of perspective or perhaps objectivity by the inspectors, has been raised when they become too familiar with those they are inspecting.

Do any of the three of you see this as a problem? Mr. Broderick felt it was a concern, that they are trying to address. Do you feel this is in any way—this is one area where I wondered if you had any recommendations for improving this tripartite maintenance system between manufacturers, users and the FAA.

Mr. COSGROVE. Oh, we have the same problem. We have fuel service representatives out at the airlines all the time, and we sometimes find that they end up by taking the airline's view rather than Boeing's view, and the only way you can fix tht problem is just move them around.

And, I don't know that it's a problem, but I do know that it does happen. At least, at Boeing it does happen. I'm sure it must happen in the FAA.

Senator KASSEBAUM. Maybe it is not a problem, as you say, so much as something that one has to be constantly aware of, and vigilant for when changes in personnel become necessary.

Does anyone have any further observations on recommendations for improving our methods of operation regarding safety?

I thank you very much for your testimony. I appreciate your being here this morning.

That concludes the hearing.

[Whereupon, at 12:25 p.m., the subcommittee was adjourned.]

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